SR/OIAF/2003-02/S

Analysis of S.139, the Climate Stewardship Act of 2003:

Highlights and Summary

June 2003

Energy Information Administration
Office of Integrated Analysis and Forecasting
U.S. Department of Energy
Washington, DC 20585

Contacts

This report was prepared by the staff of the Office of Integrated Analysis and Forecasting, Energy Information Administration (EIA). General questions concerning the report can be directed to Mary J. Hutzler (mary.hutzler@eia.doe.gov, 202/586 6351), Director of the Office of Integrated Analysis and Forecasting; Paul D. Holtberg (paul.holtberg@eia.doe.gov, 202/586 1284), Director, Demand and Integration Division; John Conti (john.conti@eia.doe.gov, 202/586 4430), Director, International, Economic and Greenhouse Gases Division and Acting Director of the Coal and Electric Power Division; James M. Kendell (jkendell@eia.doe.gov, 202/586 9646), Director, Oil and Gas Division; and Andy S. Kydes (andy.kydes@eia.doe.gov, 202/586 2222), Senior Technical Advisor.

Specific questions about the report can be directed to the following analysts:

Highlights/Summary	Daniel H. Skelly	202/586-1722	dskelly@eia.doe.gov
Chapter 1	Paul D. Holtberg	202/586-1284	paul.holtberg@eia.doe.gov
Chapter 2	Andy S. Kydes	202/586-2222	akydes@eia.doe.gov
Chapter 3	Andy S. Kydes	202/586-2222	akydes@eia.doe.gov
	Daniel H. Skelly	202/586-1722	dskelly@eia.doe.gov
	Paul F. McArdle	202/586-1722	paul.mcardle@eia.doe.gov
Chapter 4:			
Residential	John H. Cymbalsky	202/586-4815	jcymbals@eia.doe.gov
	Steven H. Wade	202/586-1678	swade@eia.doe.gov
Commercial	Erin E. Boedecker	202/586-4791	erin.boedecker@eia.doe.gov
Industrial	T. Crawford Honeycutt	202/586-1420	choneycu@eia.doe.gov
Transportation	John D. Maples	202/586-1757	john.maples@eia.doe.gov
Chapter 5	J. Alan Beamon	202/586-2025	jbeamon@eia.doe.gov
Chapter 6:			
Natural Gas	Philip M. Budzik	202/586-2847	philip.budzik@eia.doe.gov
Petroleum	Han-Lin Lee	202/586-4247	han-lin.lee@eia.doe.gov
	Anthony F. Radich	202/586-0504	anthony.radich@eia.doe.gov
Coal	Michael L. Mellish	202/586-2136	mmellish@eia.doe.gov
Chapter 7	Ronald F. Earley	202/586-1398	ronald.earley@eia.doe.gov

Other contributors to the report include Scott Sitzer, Joseph Benneche, Bill Brown, Zia Haq, James Hewlett, Jeffrey Jones, Diane Kearney, Nasir Khilji, Paul Kondis, Tom Leckey, Amar Mann, Phyllis Martin, Paul McArdle, Chris Namovicz, Chetha Phang, Eugene Reiser, Esmeralda Sanchez, Yvonne Taylor, Brian Unruh, Dana Van-Wagener, and Peggy Wells.

For ordering information and questions on other energy statistics available from EIA, please contact EIA's National Energy Information Center. Addresses, telephone numbers, and hours are as follows:

National Energy Information Center, EI 30
Energy Information Administration
Forrestal Building
Washington, DC 20585
9 a.m. to 5 p.m., eastern time, M-F

Telephone:	202/586 8800	E mail: infoctr@eia.doe.gov
FAX:	202/586 0727	World Wide Web Site: http://www.eia.doe.gov/
TTY:	202/586 1181	FTP Site: ftp://ftp.eia.doe.gov/

Preface

On January 9, 2003, Senators John McCain and Joseph I. Lieberman introduced Senate Bill 139 (S.139), the Climate Stewardship Act of 2003, in the U.S. Senate. S.139 would require the Administrator of the U.S. Environmental Protection Agency (EPA) to promulgate regulations to limit greenhouse gas emissions. On January 28, 2003, Senator James M. Inhofe requested that the Energy Information Administration (EIA) perform a comprehensive analysis of S.139. On April 2, 2003, Senators McCain and Lieberman, cosponsors of S.139, made a further request for analyses of their bill. This Service Report responds to both requests.

To analyze S.139, EIA used an updated version of the *Annual Energy Outlook 2003* (*AEO2003*) reference case. *AEO2003* was generated using EIA's National Energy Modeling System (NEMS). S.139 proposes a detailed program for greenhouse gas emission monitoring and control and contains provisions that are either subject to varying interpretation or are intended to be defined after enactment. Based on EIA's interpretation of the S.139, modifications were made in NEMS to allow modeling of its specific provisions.

The report summarizes the provisions of S.139 and the requests from Senators McCain and Lieberman and Senator Inhofe. It discusses the methodology used for the analysis, the key assumptions made based on EIA's interpretation of the proposed bill, and lists the scenarios examined as part of the analysis. It presents the projected impact of S.139 on greenhouse gases and the role of offsets. The report examines the impacts of S.139 on the four end-use demand sectors—residential, commercial, industrial, and transportation—and on electricity supply. The analysis also examines the implications of S.139 for fossil fuel supplies, including production, prices, and employment. It discusses the macroeconomic impacts of S.139 under different policy assumptions. Appendix A presents the request letters and subsequent correspondence with the requesters' staff.

The legislation that established EIA in 1977 vested the organization with an element of statutory independence. EIA does not take positions on policy questions. It is the responsibility of EIA to provide timely, high-quality information and to perform objective, credible analyses in support of the deliberations of both public and private decisionmakers. This report does not purport to represent the official position of the U.S. Department of Energy or the Administration.

Within its Independent Expert Review Program, EIA arranged for leading experts in the fields of energy and economic analysis to review this analysis and provide comment. The reviewers provided comments on a draft version of the report, after an earlier meeting with EIA to discuss the methodology and preliminary results. All comments from the reviewers either have been incorporated or were considered for incorporation. Due to time limitations, EIA was not able to complete all the sensitivity cases suggested by the reviewers. The basis of the sensitivities included in this analysis was to respond to the requests of the Senators soliciting this analysis. As is always the case when peer reviews are undertaken, not all the reviewers are in agreement with all the methodology, inputs, and conclusions of the final report. The contents of this report are solely the responsibility of EIA. The assistance of the following reviewers in preparing the report is gratefully acknowledged:

Vicki Arroyo
Pew Center on Global Climate Change

Dallas Burtraw
Resources for the Future

Denny Ellerman
Massachusetts Institute of Technology

W. David Montgomery
Charles River Associates

Billy Pizer
Resources for the Future

Richard Richels
Electric Power Research Institute

John Weyant
Stanford University

The projections in the reference case in this report are not statements of what will happen but of what might happen, given the assumptions and methodologies used. The reference case projections are business-as-usual trend forecasts, given known technology, technological and demographic trends, and current laws and regulations. Thus, they provide a policy-neutral reference case that can be used to analyze policy initiatives. EIA does not propose, advocate, or speculate on future legislative and regulatory changes. All laws are assumed to remain as currently enacted; however, the impacts of emerging regulatory changes, when defined, are reflected.

Contents

Figures (Continued)

Highlights

Introduction

This analysis of Senate Bill 139 (S.139), the Climate Stewardship Act of 2003, was requested by Senator James M. Inhofe, Chairman of the Senate Environment and Public Works Committee, and by Senators John McCain and Joseph I. Lieberman, who introduced the bill. The analysis responds to both requests.

Highlights of S.139

- S.139 would establish regulations to limit U.S. emissions of greenhouse gases, primarily through a system of tradable emission allowances and related emissions reporting requirements.

- The bill covers emissions of six greenhouse gases: carbon dioxide, methane, nitrous oxide, and three gases with high global warming potential (GWP)—hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. The bill's allowance requirements cover about 75 percent of direct emissions in the United States. Covered sources include entities in the commercial, industrial, and electric power sectors with annual greenhouse gas emissions above a threshold level of 10,000 metric tons carbon dioxide equivalent;[1] transportation uses of petroleum products; and producers and importers of high-GWP gases.

- Emissions sources excluded are entities in the residential and agriculture sectors with direct emissions and entities with annual emissions below 10,000 metric tons carbon dioxide equivalent (based on GWP). Noncovered entities are affected by the bill, however, because emissions from the electricity they use are subject to the bill's allowance program, and because prices for natural gas are expected to rise as demand for the low-carbon fuel increases under the program.

- Emissions allowance caps are introduced in two phases. Phase I allowance caps, in effect from 2010 to 2015, are based on the emissions from covered sources in 2000. The Phase II caps, in effect after 2015, are based on 1990 emissions. The bill provides incentives and flexibility measures to spur early action and give credit for past emission reduction efforts, including:

    - A banking provision that allows entities to save allowances for future use, providing an incentive to overcomply early, when the allowance limit is relatively low, easing the transition to more stringent limits in Phase II, beginning in 2016
    - Emission allocation rules that reward past reductions with increases in the initial allocation of allowances
    - Allocation of emission-based marketable credits to automotive manufacturers for corporate average fuel economy (CAFE) improvements that are more than 20 percent over the relevant standard
    - A Climate Change Credit Corporation, funded by allowance sales, with authority to provide programs for transition assistance and to reduce economic impacts, which could take the form of rebates for purchases of efficient appliances and other transfer payments.

1 Most commercial entities would not be covered. Most industrial and electric power companies would be covered.

Summary of the S.139 Analysis and Results

Total Greenhouse Gas Emissions Reach 2000 Levels by 2025. Total greenhouse gas emissions are estimated to reach 2000 levels by 2025, with the gradual decline in U.S. greenhouse gas emissions starting in 2010. Covered entities are expected to overcomply in Phase I, in order to bank allowances. Beginning in 2016, when the more stringent Phase II allowance caps go into effect, covered entities would use previously banked allowances, enabling them to reduce their emissions (about 75 percent of the total) to near 1990 levels over the next decade. Emissions from noncovered entities grow moderately through 2025. Total emissions (covered and noncovered) reach 2000 levels by 2025. These changes in emissions do not reflect increases in carbon sequestration and purchases of emissions reductions abroad that are also used to comply with the targets in the legislation.

Allowance Values Grow Over Time. Prices in the emission allowance program are expected to increase gradually from $79 per metric ton carbon equivalent in 2010 ($22 per metric ton carbon dioxide equivalent) to $221 per metric ton carbon equivalent in 2025 ($60 per metric ton carbon dioxide equivalent).[2] The S.139 provisions to allow banking of emissions allowances are expected to moderate price increases as arbitrage occurs in allowance trading and banking.

A Supplementary Market for Tradable Offsets Develops. The bill provides an incentive for noncovered entities to make reductions and register them, so that they can be sold to covered entities for use in place of allowances. An organized market for offsets is expected to develop, and covered entities are assumed to take advantage of the maximum allowable amount of offsets (15 percent of the allowance requirement in Phase I and 10 percent in Phase II). The offset limits, combined with the generally lower costs of initial reductions from offset sources, are expected to result in a lower market price for offsets than for allowances. Estimated prices of offsets in 2025 are $52 per metric ton carbon equivalent, well below the price of allowances ($221 per metric ton carbon equivalent).[3]

2025 End-Use Prices Increase by 27 Percent for Motor Gasoline and 46 Percent for Electricity. In the S.139 analysis case, gasoline prices increase by 19 cents per gallon in 2010 and by 40 cents per gallon in 2025 relative to the prices projected in the reference case. Electricity costs increase by 0.6 cents per kilowatthour in 2010 (9 percent) and by 3 cents in 2025 (46 percent). The average household's energy bill, including the fuel cost of personal transportation, is expected to increase by $444 dollars per year in 2025 (13 percent) relative to the reference case.

Allowance Proceeds Offset Consumer Impacts. The increase in the average household's energy expenses is significantly mitigated by appliance rebates, transition assistance, and other transfer payments provided by the Climate Change Credit Corporation, a new nonprofit organization created under the bill and funded with revenues from emission allowance sales.

By 2025, Average Delivered Prices to Covered Entities Increase by 31 Percent for Petroleum Products, 79 Percent for Natural Gas, and 485 Percent for Coal. Covered entities must hold allowances for their greenhouse gas emissions. The costs of the allowances add to the effective price of fossil fuels delivered to the covered sectors. The large percentage increase in the cost of coal reflects both its high carbon content and its relatively low initial price. On a dollar-per-Btu basis, coal remains the lowest cost fossil fuel under the bill, but its use is expected to be greatly reduced as a direct consequence of the allowance program.

---

[2] Prices are in constant 2001 dollars, unless otherwise noted.

[3] In a sensitivity case without a binding offset limit, the use of offsets increases and the overall cost of compliance, as reflected in the allowance and offset prices from 2010 to 2025, decreases by about 20 percent.

Macroeconomic Impacts Reduce Gross Domestic Product (GDP). The economy's adjustment to increasing energy costs through 2025 under the bill is expected to reduce real GDP and disposable income, with the degree and timing of the impacts determined in part by how proceeds from allowance sales are distributed. Assuming that the amount of auctioned allowances grows over time, the maximum percentage reduction in projected GDP compared to the reference case in any year is 0.7 percent.[4] The projected average annual growth rate of GDP from 2001 to 2025 is 3.02 percent with the bill and 3.04 percent without it. Expressed in dollar terms, the reduction in the present discounted value of GDP over the forecast period is $507 billion (in 1996 dollars). In 2025, when the adjustment to the S.139 regime is largely complete, actual GDP in the S.139 case is $106 billion (0.6 percent) lower than in the reference case.

Personal Disposable Income Is Also Reduced. Reductions in disposable income are similar in magnitude to the reductions in GDP, with the greatest changes occurring in the 2010-2015 time frame, when the assumed percentage of allowances allocated to the Climate Change Credit Corporation and rebated to consumers is the lowest. Over the 22-year time frame of the analysis, the cumulative difference in discounted disposable income relative to the reference case is $1,037 per capita, or about $47 per person per year (1996 dollars). Without discounting, the cumulative difference in disposable income relative to the reference case is $2,459 per capita, or $112 per person per year.

The Electric Power Sector Dominates Emission Reductions. The electric power sector is expected to provide by far the greatest share of emissions reductions, mainly through fuel substitution on the supply side but also through demand changes from higher electricity prices. Total energy-related carbon dioxide emissions in 2025 are reduced by 752 million metric tons carbon equivalent relative to the reference case, with the electricity sector's reduction amounting to 663 million metric tons. The electricity sector is more flexible in reducing emissions because of its potential to substitute towards lower carbon fuels, adopt emission-free alternatives, and implement carbon sequestration technology for fossil-fueled plants. To a great extent, these options can reduce emissions at a lower per-ton cost than in other energy-consuming sectors.

Coal Use Declines Sharply; New Nuclear Power Plants Are Added; Use of Renewable Energy Increases. The use of coal, particularly for electric power, is expected to decline rapidly, with generators substituting capacity fueled by natural gas, nuclear, and renewable fuels, and building plants equipped with carbon sequestration technology. Geological sequestration of carbon dioxide for coal and natural gas plants is expected to become economical, resulting in 140 gigawatts of capacity equipped with this technology (38 gigawatts using coal) by 2025. Nuclear power, which produces no greenhouse gas emissions, becomes more economical under S.139. Nuclear generation is expected to increase by 50 percent by 2025, with investments in a new generation of advanced plants beginning as early as 2012. Renewable energy use increases under S.139, particularly in the electricity sector, as additions of biomass and wind capacity, along with more modest increases in geothermal and landfill gas capacity, increase relative to the reference case. The estimated share of generation supplied by renewables, including hydroelectricity, increases from 8 percent in the reference case in 2025 to 23 percent in the S.139 case.

Transportation Energy Use Falls. Transportation petroleum use declines by 0.3 quadrillion Btu (1 percent) in 2010 and 4.1 quadrillion Btu (10 percent) in 2025 under the bill, compared to the reference case level, as the prices of travel-related emission allowances are passed on to consumers, who respond by buying more fuel-efficient vehicles and traveling less. Automotive manufacturers, who are given incentives under the bill to exceed fuel economy standards by at least 20 percent, are expected to respond gradually to the incentives, while continuing to maintain vehicle comfort, safety, and performance. By

[4] The maximum percentage change occurs in 2012 and amounts to a difference of $93 billion (1996 dollars).

2025, new light vehicle fuel economy (cars and light trucks together) reaches 29.0 miles per gallon, compared with 26.4 miles per gallon in the reference case.

Petroleum Imports Decline. U.S. petroleum demand is estimated to fall by 0.3 million barrels per day in 2010 and by 2.7 million barrels per day in 2025 compared to the reference case, reducing projected oil import dependence in 2025 from 67.8 percent to 64.7 percent of total U.S. oil supply.

Allowance Values and GDP Impacts Are Lower Under High Technology Assumptions. Under more optimistic assumptions about the future availability, costs, and performance of advanced energy-using technologies, the cost of compliance for S.139 is lower. In a high technology sensitivity case, allowance prices in 2025 are reduced by 28 percent compared to the S.139 case. The reduction in the size of the economy in 2025 is $106 billion in the S.139 case and $95 billion in the S.139 high technology case (1996 dollars).

A Lower Natural Gas Supply Outlook and Higher Natural Gas Prices Result in Greater Adoption of Nuclear and Renewable Technologies and Increase the Use of Coal with Carbon Sequestration. More pessimistic assumptions for natural gas supplies, including recoverable reserves and undiscovered resources, result in projected wellhead prices in 2025 that are 40 percent higher than in the reference case. An S.139 sensitivity case with higher gas prices results in changes in compliance strategies, particularly in the electricity sector. Generating capacity substituted for natural gas additions includes coal-fired plants with carbon sequestration, as well as nuclear and renewables. As a result, overall coal consumption in this sensitivity case is 237 million tons higher than in the S.139 case in 2025, but at 543 million tons it is significantly lower than in the reference case (1,466 million tons). The overall cost of compliance, as indicated by the allowance prices, is about 6 percent higher in the S.139 high gas price case than in the S.139 case.

The Results Are Inherently Uncertain. An assessment of the impact of S.139 over a 25-year period is subject to considerable uncertainty. The baseline forecast (which is itself uncertain) affects the amount of change needed to meet an emissions target, as do the modeling methodology and assumptions. Alternative assumptions about the cost, performance, and market acceptance of these technologies affect the results, as do other assumptions, including the distribution of emission allowances to covered entities, the availability and cost of international offsets, future policy changes affecting energy use, and the extent of coverage and reduction potential of emissions sources. Sensitivity analysis is used to address some of these issues but does not necessarily encompass the full range of plausible energy and economic outcomes that might follow from enactment of the bill.

Summary

On January 9, 2003, Senators John McCain and Joseph I. Lieberman introduced Senate Bill 139 (S.139), the Climate Stewardship Act of 2003, in the U.S. Senate.[5] S.139 would establish regulations to limit U.S. greenhouse gas emissions, primarily through a program of tradable emission allowances and related emissions reporting requirements. The emissions allowance program would apply to most greenhouse gas emissions sources, the exceptions being those in the residential and agriculture sectors, as well as organizational entities in all sectors whose annual emissions are less than a certain threshold.

On January 28, 2003, Senator James M. Inhofe requested that the Energy Information Administration (EIA) perform a comprehensive analysis of S.139. On April 2, 2003, Senators McCain and Lieberman made a further request for analyses of their bill (see Appendix A for copies of the requesting letters). This Service Report responds to both requests.

This report addresses the following specific elements of Senator Inhofe's request:

- Costs of the bill to the U.S. economy in employment and aggregate gross domestic product (GDP)
- Energy conservation effects of the bill
- Comparison of the bill's compliance period with those scheduled by China, Mexico, South Korea, India, and Brazil for their greenhouse gas reduction programs
- Demographic data (by household income class) on the distribution of energy consumption and expenditures from EIA's Residential Energy Consumption Survey.

The report also responds to the following specific elements of the request from Senators McCain and Lieberman:

- Projected impacts of the bill over a range of alternative percentages of total greenhouse gas allowances to be issued by the U.S. Government that might be allocated to the Climate Change Credit Corporation—a new nonprofit organization with responsibilities defined by the bill
- Impacts of early action compliance activities by both covered and noncovered entities on the total costs of compliance
- Impacts of new technologies that could be deployed to reduce greenhouse gas emissions on the costs of compliance
- Impacts of the "allowance banking" permitted under the bill
- Effects of the bill on future levels of U.S. emissions of energy-related carbon dioxide and other greenhouse gases
- Effects of compliance flexibility measures and additional incentives to reduce emissions, including allowance credits for:
    - Registered reductions in international emissions
    - Fleet fuel efficiency improvements 20 percent greater than required
    - Emissions reductions associated with electricity use in noncovered sectors
    - Biological carbon sequestration from agricultural and forestry activities
    - Reducing emissions to 1990 levels before the bill's required date of 2010.

---

5 See web site http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=108_cong_bills&docid=f:s139is.txt.pdf.

Summary of the Climate Stewardship Act of 2003

S.139 establishes a research program on climate change and related activities, a national greenhouse gas database and registry of reductions, and a system of tradable allowances to reduce greenhouse gas emissions. The greenhouse gases addressed by the bill are carbon dioxide, methane, nitrous oxide, and gases with high global warming potential (GWP): hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. The bill establishes requirements for mandatory emissions reporting by covered entities and for voluntary reporting of emissions reduction activities. The focus of this report is on the emission allowance program and the related incentives proposed in the bill.

The bill defines the covered sectors for the emission allowance program as the commercial, industrial, electric power, and transportation sectors. The residential and agriculture sectors are exempt from the emissions reporting and allowance provisions under the bill. Covered entities in the commercial,[6] industrial, and electricity sectors are those with annual greenhouse gas emissions greater than a threshold level of 10,000 metric tons carbon dioxide equivalent. All petroleum use in the transportation sector is covered, with refiners having the responsibility to obtain allowances for emissions related to petroleum sold for transportation use. The high-GWP gases are covered, with producers and importers of these gases having the responsibility to obtain allowances for emissions associated with their supply. The bill provides for the exemption of emission sources if the U.S. Environmental Protection Agency (EPA) deems their measurement or estimation to be impractical. This exemption would most likely apply to a large share of U.S. nitrous oxide and methane emissions, because many of their sources are difficult or uneconomical to measure.

The bill's market-driven system of emission allowances would control greenhouse gas emissions by creating a fixed number of tradable emission allowances each year. The EPA is charged with establishing the regulations to create the tradable allowances, and S.139 defines many of the provisions governing the allowances. The bill provides entities with options for banking and borrowing allowances; for limited use of registered reductions from noncovered entities in lieu of allowances;[7] and for obtaining allowance allocation credits to reward past emissions reductions and early action reductions. S.139 establishes a nonprofit Climate Change Credit Corporation (hereafter referred to as the Corporation) to facilitate the market in emission allowances, to buy and sell allowances, and to distribute proceeds from sales in order to reduce the economic impacts of the program. The bill gives responsibility to the Secretary of Commerce for defining the allocation of allowances to the covered sectors and to the Corporation, subject to the final approval of Congress.

Each emission allowance provides the right to emit one ton of greenhouse gases, measured in carbon dioxide equivalent units based on 100-year GWP. The number of allowances created each year effectively establishes a cap on total U.S. emissions; however, with the banking of allowances for future use permitted under the bill, emissions in any year may differ from the number of allowances issued.[8] The bill requires covered entities to submit allowances equal to their emissions but does not limit the emissions of individual entities. Entities are free to produce any amount of emissions as long as they obtain the same

---

6 The commercial sector includes government entities.

7 The bill allows each covered entity to obtain a portion of its emission allowances from alternate compliance sources, including purchase of allowances from certified reduction or sequestration programs, both domestically and abroad. The alternate compliance limits are 15 percent from 2010 to 2015 (Phase I) and 10 percent thereafter (Phase II). As an incentive for early action, entities reducing their emissions below 1990 levels may be granted a limit of 20 percent of their target reductions from alternate compliance sources in Phase I.

8 Covered entities must submit allowances for their covered emissions or, to a limited extent, offsetting emission reduction credits from noncovered entities. Therefore, the covered emissions, less any offset credits, are subject to the allowance cap.

amount of allowances. Entities may buy and sell allowances, and they may bank allowances for future use. Under limited conditions, covered entities can borrow against future emissions reductions.[9]

S.139 allows automotive manufacturers to sell credits to the greenhouse gas registry for exceeding fleet fuel economy standards by more than 20 percent. The credits would then be used to reduce a corresponding quantity of emission allowances allocated to the transportation sector.[10] This provision establishes an emissions-related economic incentive for manufacturers to supply more efficient vehicles. Because this opportunity supplements the incentives established by the emission allowance requirement, the bill provides a somewhat greater economic incentive for emission reductions in transportation than in other sectors.

The S.139 emission allowance program would go into effect in 2010. In Phase I, 2010 through 2015, the number of allowances issued annually is based on the aggregated emissions of the covered sectors in 2000 (but reduced by the emissions of noncovered entities in those sectors in 2000). In Phase II, beginning in 2016, the number of allowances issued is based on 1990 emission levels (and reduced by emissions of noncovered entities in 1990).[11] The number of allowances created is to be reduced by an amount corresponding to the emissions from noncovered entities, such as those with emissions below the threshold level—an amount that will not be established until emissions reporting is in place. The number of emissions allowances to be issued by the Government and, consequently, the overall cap are not established exactly; however, roughly 75 percent of total U.S. greenhouse gas emissions are likely to be covered under the bill.[12]

The allocation of emissions allowances to covered sectors and entities is not completely fixed by the bill. Some of the Government-issued allowances are to be distributed directly to covered entities, and the rest are to be allocated to the Corporation. While a number of criteria for allocating emissions allowances are defined by the bill, neither the total percentage of allowances distributed free, nor the share distributed to each of the covered sectors, is defined in the bill. The bill does, however, describe an allocation procedure to reward entities for registered emissions reductions made since 1990 and reductions made in advance of the 2010 start date. Entities with creditable reductions are granted a corresponding increase in their future allocation of allowances in the compliance period beginning in 2010. These credits for early action do not affect the overall compliance cap; they only affect the allocation of free allowances to covered entities. Nevertheless, this provision provides an incentive to reduce emissions early as a means of obtaining greater allowance allocations in the future.

Approach and Scenarios

EIA analyzed the bill using the National Energy Modeling System (NEMS). The primary reference case for the analysis was based on the NEMS reference case results published in EIA's *Annual Energy Outlook 2003 (AEO2003),*[13] updated to reflect changes in electric generating capacity since the *AEO2003* was completed in January 2003; to incorporate revised expectations about near-term trends in natural gas

9 This provision requires the entity to show that a specific capital project is underway to reduce emissions, and any allowances borrowed must be returned at an effective interest rate of 10 percent per year. In addition, borrowed allowances count against the limit on alternate compliance offsets. Therefore, in the aggregate, allowance borrowing is likely to be minimal under the bill.

10 The relationship between fuel economy credits and emission allowances is to be based on the emissions reductions attributable to the higher fuel economy, as determined by the Secretary of Transportation.

11 These limits are subject to a biannual review for adequacy by the Under Secretary of Commerce for Oceans and Atmosphere.

12 Because covered entities can, to a limited extent, fulfill their allowance requirement with registered reductions from abroad and by registered increases in net sequestration, their aggregate emissions would not necessarily reach 1990 levels.

13 Energy Information Administration, *Annual Energy Outlook 2003,* DOE/EIA-0383(2003) (Washington, DC, January 2003), web site http://www.eia.doe.gov/oiaf/aeo/.

prices; and to reflect recent changes in corporate average fuel economy (CAFE) standards. In order to respond to the requests from Senators Inhofe, McCain and Lieberman, the following cases were analyzed with NEMS:

- ***S.139 Case***: This case simulates enactment of S.139, combined with *AEO2003* reference case assumptions for technology. This is the principal case used to represent the overall impacts of the bill. The other cases in the analysis are designed to test the assumptions incorporated in the S.139 case. The following assumptions are made in the S.139 case and are varied in the sensitivity cases:

  - **Allowance Banking**: Entities can overcomply (e.g., in Phase I) and bank allowances for future use (e.g., in Phase II). Arbitrage in allowance trading and banking is assumed to limit the annual growth rate of the allowance trading price.
  - **Alternate Compliance Percentage**: In aggregate, entities are assumed to obtain 16 percent of covered emissions allowances through the bill's alternate compliance provisions ("offsets") in Phase I (2010-2015), and 10 percent in Phase II (from 2016 on). Offsets come from: (1) emission reductions from noncovered entities (domestic); (2) increases in net biological carbon sequestration; and (3) international emissions reductions. The 16 percent reflects the bill's provision that some entities will be granted a 20 percent offset percentage (instead of 15 percent) in exchange for reducing their emissions to 1990 levels by 2010.
  - **Commercial Sector**: The S.139 case assumes that all entities in the commercial sector are exempt from emissions allowances and that all entities in the industrial sector are covered.
  - **Auction Percentage**: The S.139 case assumes that 20 percent of emissions allowances will be allocated to the Corporation in 2010, increasing linearly each year to 80 percent in 2025.
  - **Nuclear Power and Geological Sequestration**: The S.139 case assumes commercial availability of advanced nuclear plants and of geological carbon sequestration technologies in the electric power industry.

The following sensitivity cases were examined to analyze variations on the S.139 case:

- ***S.139 High Technology Case***: This case incorporates the high technology case assumptions.
- ***High Technology Reference Case***: This case combines the reference case assumptions with the high technology case assumptions in the *AEO2003* integrated high technology case and provides the basis for comparison with the S.139 high technology case
- ***No New Nuclear/No Sequestration Case***: This case shows the impacts of assuming that these advanced technologies would not be commercially available through 2025.
- ***S.139 High Natural Gas Price Case***: This case combines the high gas price reference case with enactment of S.139. It is intended to analyze the impact of higher natural gas prices on energy market decisions under S.139.
- ***High Natural Gas Price Reference Case***: This case assumes a more pessimistic outlook for domestic natural gas supply than in the reference case, resulting in higher natural gas prices.
- ***80 Percent and 20 Percent Allowance Auction Cases***: The S.139 case assumes that, initially, 20 percent of the emission allowances issued by the Government will be allocated to the Corporation, increasing to 80 percent by 2025. These cases show the impacts of two fixed percentages, 80 and 20 percent, allocated to the Corporation in each year of the forecast.
- ***Commercial Coverage Case***: This case assumes that all entities in the commercial sector are covered.
- ***No Banking Case***: This case assumes that the banking of emissions allowances for later use by covered entities is not incorporated as a compliance option. It is included to show the impacts of the banking provision included in S.139.

- ***S.139 International Offset Availability Cases***: This pair of cases examines the impact on the S.139 case of variability in international offset availability. The first case assumes no international offsets (low international offset supply case). The second assumes a doubling in the supply of offsets available at each price (high international offset supply case).
- ***S.139 High Percentage Offset Case***: This case examines the sensitivity of the S.139 case to increasing the percentage of allowance requirements that can be met by offsets to 50 percent in all years.

S.139 specifies the Phase I and Phase II emission allowance caps based on 2000 and 1990 data, excluding emissions from the residential sector, agriculture sector, and U.S. territories. The reference data cited in the bill are from the EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2000*.[14] The bill specifies the annual allowances for Phase I and Phase II at 5,896 and 5,123 million metric tons carbon dioxide equivalent, respectively, adding the phrase "reduced by the amount of emissions of greenhouse gases . . . from noncovered entities." Noncovered entities include those not meeting the emissions threshold of 10,000 tons carbon dioxide equivalent, as well as emissions from sources deemed impractical by the EPA to measure.

The allowance caps for this analysis are based on: (1) energy-related carbon dioxide (CO_2) emissions as reported by EIA,[15] and (2) non-CO_2 emissions from a consolidated set of data provided by EPA that combines history, projections, and reduction potential. The allowance caps are derived by summing the CO_2 emissions from the affected energy sectors, the covered portions of methane and nitrous oxide emissions, and emissions of the high-GWP gases. Using these definitions, the Phase I and Phase II caps for covered entities are estimated at 5,372 and 4,613 million metric tons carbon dioxide equivalent. Except where otherwise noted, this report follows EIA's standard practice of reporting emissions of carbon dioxide and other greenhouse gases in carbon equivalent (rather than carbon dioxide equivalent) units, defined as the weight of the carbon content of carbon dioxide (i.e., just the "C" in CO_2). Emissions in carbon equivalent terms are converted to carbon dioxide equivalent terms by multiplying by 3.6667.[16] Thus, the Phase I and Phase II caps used in this report are 1,465 and 1,258 million metric tons carbon equivalent.

Greenhouse Gas Allowance Costs

The bill's allowance trading and offset provisions would result in markets for emission allowances and offset credits. The market for these allowances and related incentives is expected to result in a gradually increasing market-clearing price for allowances that reflects both the cost of reducing emissions and the impact of allowance banking. Because allowances can be sold or held for future use, covered entities will have an incentive to reduce emissions under the bill even if they are allocated sufficient allowances to cover their annual emissions. The two-phase compliance period provides an incentive for covered entities to overcomply and bank emission allowances during the first phase (2010-2015), when the allowance cap and offset limits are relatively lenient. The bank of allowances could then be used to reduce compliance costs under the more stringent Phase II allowance and offset caps.

---

[14] U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2000,* EPA 430-R-02-003 (Washington, DC, April 2002).

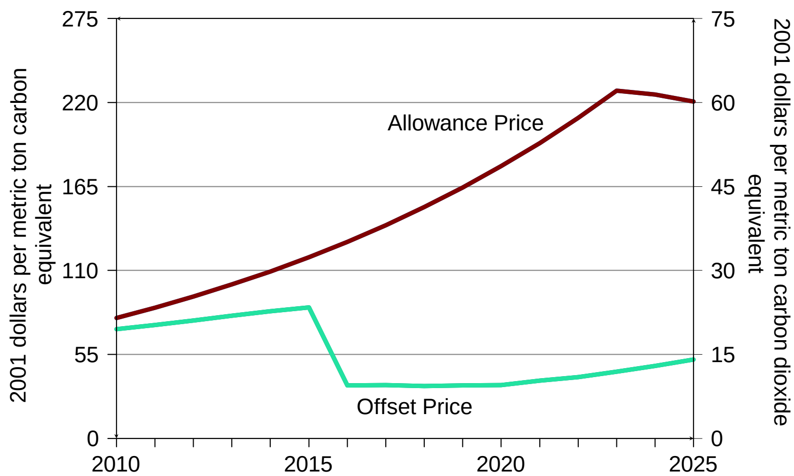
[15] Energy Information Administration, *Emission of Greenhouse Gases in the United States 2001,* DOE/EIA-0573(2001) (Washington, DC, December 2002). There are several sources of difference between EIA's carbon dioxide emissions accounting and those in the EPA inventory. One is that EIA does not subtract emissions for military and international bunker fuels. Another is that EIA recently revised its energy data accounting for fossil fuels used to generate electricity.

[16] Conversely, emissions allowance prices in carbon equivalent terms are converted to carbon dioxide equivalent terms by dividing by 3.6667.

The decisions to sell or hold allowances for the future are expected to result in a gradually increasing allowance price that grows at a rate consistent with the rate of return for similar investments. This occurs because arbitrage in allowance trading tends to equate the current prices for allowances with the present discounted value of future allowances. For this analysis, a real discount rate of 8.5 percent was assumed. As a result, allowance prices are assumed to increase annually at a maximum rate of 8.5 percent. In practice, fluctuations in year-to-year prices would occur as a result of imperfect information and unexpected events.

The market for offset credits is conceptually similar to the allowance market. The bill provides an incentive for noncovered entities to make reductions and register them so they can be sold to covered entities. An organized market for these offsets is expected to develop, and almost all covered entities are expected to obtain and use the maximum allowable amount of offsets. In Phase I, covered entities can use offset credits to meet up to 15 percent of the allowance requirement (or 20 percent if they reach 1990 emissions levels by 2010). In Phase II, the offset limit is 10 percent. The offset limits, combined with the generally lower costs of initial reductions from offset sources, are expected to result in a lower market price for offsets than for allowances in the S.139 case (Figure S.1). If the limits on offsets were not binding, the market price for offsets and allowances would equalize.[17] In Phase II, the limit on offsets falls to 10 percent, which tends to lower the market-clearing price for offsets, because only the cheapest offset reductions are implemented to generate credits for use in meeting allowance requirements.

Figure S.1. Estimated Greenhouse Gas Allowance and Offset Prices in the S.139 Case, 2010-2025



Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System run MLBILL.D050503A.

Table S.1 compares the emissions-related results of the reference and S.139 cases for 2010, 2016, and 2025. For the most part, reductions in greenhouse gas emissions are expected to be phased in gradually, with some reductions occurring before the beginning of the first commitment period in 2010 (Figure S.2). The reductions occur both from the actions of covered entities and from the participation of noncovered entities that can register reductions voluntarily and sell them as offsets.

---

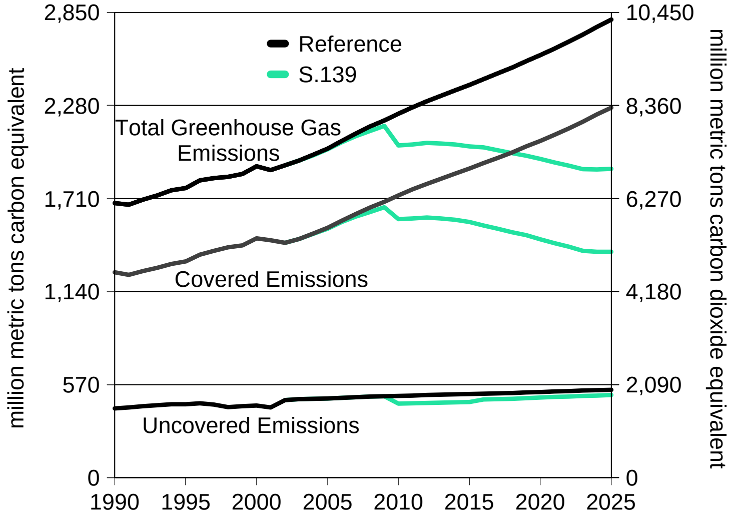
17 A sensitivity case is used to test the effect of the offset limit. In that case, the prices of the offset and allowance market equalize.

Table S.1. Summary of Greenhouse Gas Emission Results, Reference and S.139 Cases, 2010, 2016, and 2025 (million metric tons carbon equivalent)

		2010		2016		2025	
	2001	Reference	S.139	Reference	S.139	Reference	S.139
Greenhouse Gas Emissions							
Energy-Related Carbon Dioxide	1,559	1,802	1,710	1,968	1,656	2,234	1,482
Non-Energy Carbon Dioxide	36	40	40	42	42	46	46
Methane	175	178	115	176	127	172	120
Nitrous Oxide	119	127	121	133	127	143	137
High-GWP Gases (HFCs, PFCs, and SF_6)	39	84	50	123	71	209	106
Total	**1,928**	**2,230**	**2,036**	**2,442**	**2,023**	**2,806**	**1,891**
S.139 Compliance Summary							
Covered Energy-Related Carbon Dioxide	1,379	1,605	1,513	1,763	1,452	2,014	1,257
Other Covered Emissions	75	124	70	163	91	251	128
Total Covered Emissions	**1,454**	**1,729**	**1,583**	**1,926**	**1,544**	**2,265**	**1,385**
Offset Reductions Purchased							
Noncovered Greenhouse Gases	—	—	49	—	36	—	39
Increases in Biological Carbon Sequestration	—	—	113	—	90	—	87
International Offsets	—	—	73	—	0	—	0
Total Offset Reductions	—	—	**235**	—	**126**	—	**126**
Covered Emissions, less Offsets	1,454	1,729	1,349	1,926	1,418	2,265	1,259
Emission Allowances Issued	—	—	1,465	—	1,258	—	1,258
Net Allowance Bank Change (+, deposit; -, withdrawal)	—	—	+117	—	-160	—	-1
Greenhouse Gas Emission Allowance Price							
(2001 dollars per metric ton carbon equivalent)	—	—	79	—	129	—	221
(2001 dollars per metric ton carbon dioxide equivalent)	—	—	*22*	—	*35*	—	*60*
Offset Trading Price							
(2001 dollars per metric ton carbon equivalent)	—	—	71	—	35	—	52
(2001 dollars per metric ton carbon dioxide equivalent)	—	—	*19*	—	*9*	—	*14*

Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBASE.D050303A and MLBILL.D050503A. Data on greenhouse gas emissions for 2001 from Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2001*. Forecasts of reference case greenhouse gas emissions other than carbon dioxide from reference materials provided by the U.S. Environmental Protection Agency for a business-as-usual case, developed in preparing the *Climate Change Action Report 2001* and extrapolated to 2025. Chapters 2 and 3 discuss related issues and data sources in more detail.

Figure S.2. U.S. Greenhouse Gas Emissions in the Reference and S.139 Cases, 1990-2025



Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBASE.D050303A and MLBILL.D050503A.

As a result of the allowance banking provisions, covered entities are expected to overcomply in Phase I (2010-2015). In 2010, total covered emissions are 1,583 million metric tons carbon equivalent and offset credits, which can be submitted in place of allowances, are 235 million metric tons carbon equivalent (Table S.1). Emissions allowances for the difference (1,349 million metric tons carbon equivalent) would be submitted in compliance with the bill. Given the estimated 1,465 million allowances issued in 2010, 117 million allowances can be banked for future use. The balance of banked allowances is expected to accumulate from 2010 to 2015, followed by its gradual depletion in Phase II (2016 and beyond). By the end of 2023, the bank balance is depleted, and emissions nearly level out, with the remaining growth coming from noncovered emission sources.[18]

NEMS simulates the energy market in detail and develops endogenous estimates of energy-related carbon dioxide emissions, the principal component of the greenhouse gases analyzed. The availability and costs of offsets, as well as the potential for reductions of covered greenhouse gases other than energy-related carbon dioxide, are based on assumptions exogenous to NEMS. These modeling assumptions are derived from reports and other research from the EPA. The assumptions are reflected in marginal abatement cost curves for greenhouse gas emissions and offsets from outside the energy sector. These assumptions, as well as other methodological issues, are discussed in Chapters 2 and 3. NEMS combines its estimates of carbon dioxide emissions with this information to simulate the allowance and offset markets.

NEMS estimates allowance prices and reflects the allowance prices in the costs of consuming fossil fuel. The demand for fossil fuel adjusts to the higher prices, thereby reducing the associated carbon dioxide emissions. Demand adjustments are varied and include short- and long-term changes, as discussed below. The impacts of allowance prices on energy costs and the economy are simulated in the macroeconomic component of NEMS, also discussed below. Offset prices are determined by the intersection of the offset supply curve and the cap on offsets specified by S.139.

---

[18] Not reflected in Figure S.2 are changes in domestic biological carbon sequestration that are expected to be registered and purchased as offsets. In addition, some of the offsets purchased would be from international sources, as allowed in the bill. This topic is addressed in Chapter 3.

Energy Market Impacts

Energy consumers are expected to face higher effective costs of using energy as a result of the bill's allowance program. In the transportation sector, end-use consumers will face higher delivered prices of refined products, because refiners must obtain allowances for the greenhouse gas emissions associated with petroleum-based fuels sold for transportation. The cost of the allowances will be included in prices of the fuels.[19] Covered entities in the commercial,[20] industrial, and electric power sectors will implicitly face a higher cost of consuming fossil energy, because they will be required to obtain allowances for the carbon dioxide emitted in direct fuel use. To the extent that electricity generators can pass through the opportunity cost of allowances and related incremental capital costs to their customers, electricity prices will increase in all consuming sectors.[21] The increased energy costs, whether incorporated in delivered prices or reflected implicitly as opportunity costs of consuming energy, will affect all energy sectors of the economy. ***To simplify discussion of energy costs, the delivered prices of energy discussed in this section represent the effective delivered cost of using energy, including the direct and indirect costs of emissions allowances as applicable to the given sector***.[22]

Table S.2 presents a summary of the key energy-related results for 2010, 2016, and 2025 for the reference and S.139 cases, including the carbon dioxide emissions results. Tables of the complete results for all the cases are included in the full report, Appendixes C through I.

Delivered prices of coal, natural gas, petroleum, and electricity all increase in the S.139 case relative to the reference case (Figure S.3) as a consequence of the emissions allowance program. Figure S.4 shows the percentage change in delivered prices from the reference case to the S.139 case. In percentage terms, coal prices are most affected by S.139: the price in the S.139 case is 474 percent above the reference case price in 2025. Natural gas prices in the S.139 case are 46 percent above the reference case prices in 2025, average petroleum product prices are 29 percent higher, and prices for petroleum-based transportation fuels are 31 percent higher. These price changes reflect supply and demand shifts as well as allowance costs. For example, the reduced U.S. demand for oil in the S.139 case is expected to reduce the world oil price by 7 percent and help mitigate the price impact on final consumers. The increased U.S. demand for natural gas works in the opposite direction, increasing the market-clearing price of gas at the wellhead. Electricity prices, reflecting the higher cost of using fossil fuels for generation and the incremental cost of plant investments to reduce greenhouse gas emissions (e.g., by replacing coal-fired plants that do not sequester carbon dioxide), are 46 percent above the reference case level in 2025. Compared with the changes in coal prices, the average percentage increase in the remaining energy prices is relatively modest. This reflects both the substantially higher initial prices of other fossil fuels and their lower emissions of carbon dioxide per unit of energy.

---

[19] Note that refineries, as industrial entities, would be required to obtain allowance permits for the fuel they burn in refining oil, in addition to allowances for downstream emissions of the transportation fuel they sell.

[20] While entities in the commercial and industrial sector with emissions greater than 10,000 metric tons of carbon dioxide per year are covered by the bill's allowance program, we have assumed in the S.139 case that no commercial entities are covered and that all industrial entities, with the exception of agriculture, are covered. This assumption is based partly on the lack of data on emissions by entities as defined by the bill. See Chapter 2 for a discussion of coverage assumptions.

[21] It is assumed that 90 percent of the allowance revenue acquired from the sale of greenhouse gas allowances by regulated utilities would be used to mitigate the electricity price increases of its customers and only 10 percent would be allocated to the shareholders as profits.

[22] The prices that do not include allowance costs are fossil fuels used by noncovered entities in the residential, commercial, and agricultural sectors, which do not need allowances.

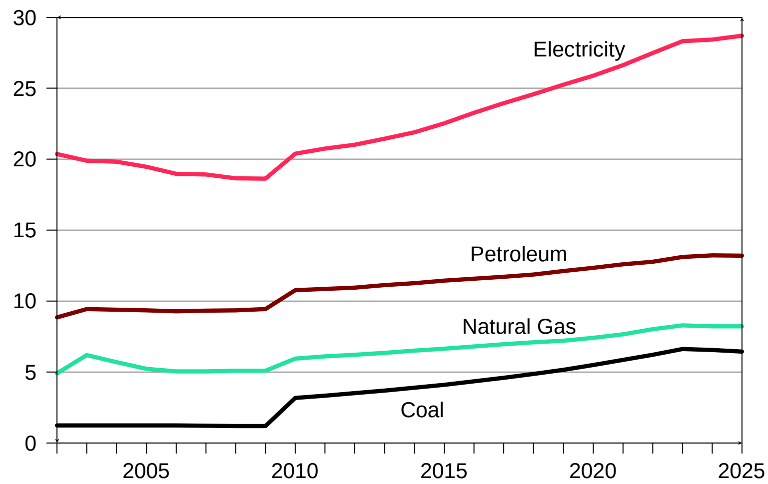
Table S.2. Summary of Energy Sector Results, Reference and S.139 Cases, 2010, 2016, and 2025

Summary Indicators	2000	2001	2010 Reference	2010 S.139	2016 Reference	2016 S.139	2025 Reference	2025 S.139
Greenhouse Gas Allowance Cost (2001 dollars per metric ton)	—	—	—	79	—	129	—	221
Effective Delivered Energy Prices (2001 dollars per million Btu)								
Coal	1.24	1.26	1.18	3.18	1.16	4.34	1.12	6.44
Natural Gas	5.59	6.40	5.15	5.96	5.40	6.80	5.64	8.22
Motor Gasoline	12.42	11.57	11.45	12.98	11.33	13.70	12.07	15.31
Jet Fuel	7.26	6.20	5.66	7.10	6.03	8.24	6.72	10.35
Distillate Fuel	10.05	9.16	9.15	10.45	9.33	11.29	9.90	13.17
Electricity	20.18	21.34	18.76	20.40	19.28	23.28	19.66	28.70
Primary Energy Use (quadrillion Btu)								
Natural Gas	24.07	23.26	27.35	28.12	30.53	32.42	35.55	39.54
Petroleum	38.53	38.46	44.45	43.74	49.20	47.02	56.11	50.76
Coal	22.64	22.02	25.47	22.00	26.94	15.86	29.86	6.74
Nuclear	7.87	8.03	8.25	8.37	8.28	8.80	8.28	12.39
Renewable	5.95	5.32	7.30	9.03	7.94	12.76	8.77	16.22
Other	0.31	0.21	0.31	0.43	0.24	0.49	0.06	0.32
Total	**99.37**	**97.29**	**113.13**	**111.67**	**123.12**	**117.35**	**138.63**	**125.97**
Electricity Sales (quadrillion Btu)	11.73	11.65	14.00	13.82	15.53	14.75	17.90	15.87
Carbon Dioxide Emissions by Fuel (million metric tons carbon equivalent)								
Natural Gas	341	329	391	402	437	452	509	493
Petroleum	659	668	761	748	843	806	963	870
Coal	579	561	650	560	688	398	763	119
Total	**1,578**	**1,559**	**1,802**	**1,710**	**1,968**	**1,656**	**2,234**	**1,482**
Carbon Dioxide Emissions by Sector (million metric tons carbon equivalent)								
Residential	317	314	355	326	372	275	406	181
Commercial	274	279	320	291	352	251	411	166
Industrial	477	451	500	472	534	448	592	391
Transportation	510	514	628	622	709	681	826	744
Total	**1,578**	**1,559**	**1,802**	**1,710**	**1,968**	**1,656**	**2,234**	**1,482**
Electricity Generation	621	612	697	615	759	485	868	205
Carbon Dioxide Reductions by Sector (million metric tons carbon equivalent)								
Residential	—	—	—	29	—	97	—	225
Commercial	—	—	—	29	—	101	—	245
Industrial	—	—	—	28	—	86	—	201
Transportation	—	—	—	6	—	28	—	82
Total	—	—	—	**92**	—	**312**	—	**752**
Electricity Generation Component	—	—	—	82	—	274	—	663

Notes: “Other” includes net electricity imports, methanol, and liquid hydrogen. “Effective Delivered Energy Prices” include cost of greenhouse gas allowances.

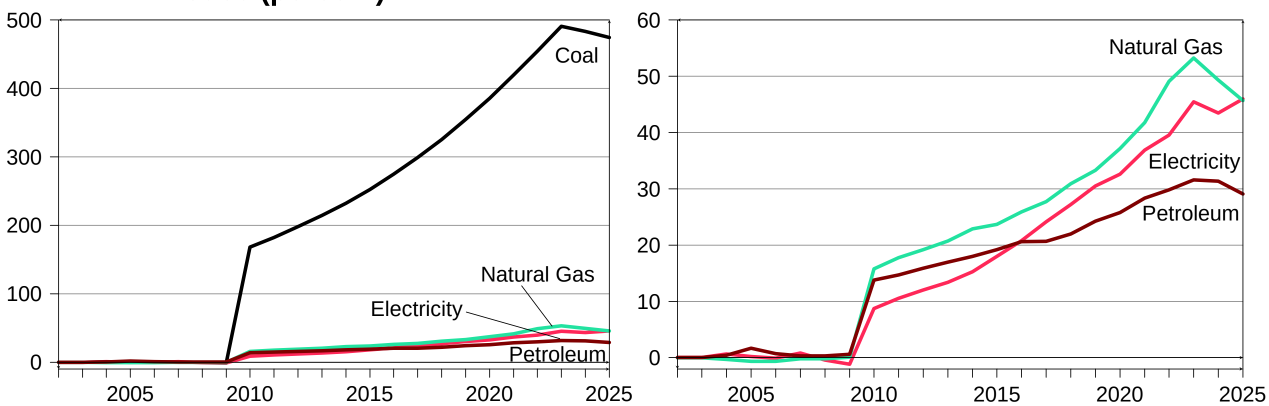
Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBASE.D050303A and MLBILL.D050503A.

Figure S.3. Effective Delivered Energy Prices in the S.139 Case, 2002-2025 (2001 dollars per million Btu)



Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBILL.D050503A.

Figure S.4. Effective Delivered Energy Prices in the S.139 Case: Change from Reference Case (percent)



Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBASE.D050303A and MLBILL.D050503A.

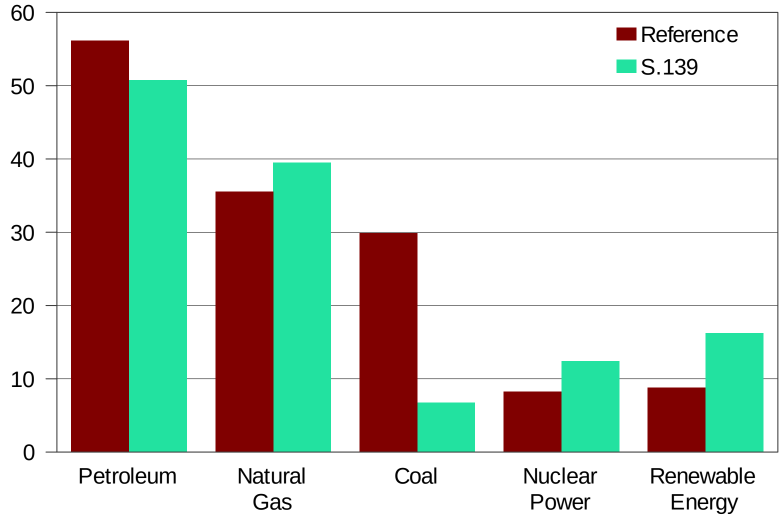
The cap on greenhouse gas emissions imposed by S.139 favors fuels and technologies with low emissions. Because the carbon dioxide emissions factor for natural gas is 56 percent of the rate for coal,[23] natural gas use is expected to increase under the bill. More electricity is projected to be produced from renewable and nuclear power in the S.139 case, with fuel costs for these technologies unaffected by greenhouse gas allowance costs. Cost-of-service electricity pricing, which is assumed for some parts of the country, would ameliorate the impacts of S.139 to a certain extent, with consumers expected to benefit from allowances allocated freely to regulated utilities. In addition, nonfuel operating and maintenance costs and capital equipment costs have a larger role in setting electricity prices under cost-of-service

[23] The emissions factors cited reflect emissions per unit of fuel consumed and do not reflect differences in fuel efficiency related to the fuel's use (e.g., for electricity generation).

pricing. In regions where electricity prices are assumed to be set competitively on the basis of marginal costs, greenhouse gas allowance costs would have a more significant influence on electricity prices.

By 2025, the mix of fuels consumed in the S.139 case differs significantly from that in the reference case (Figure S.5). Changes in relative fuel prices cause a reduction in coal and petroleum use, along with a greater reliance on natural gas, renewable energy, and nuclear power. The use of coal, with its high carbon content and relatively low efficiency in existing steam generation, is greatly reduced under S.139. It is replaced by more use of natural gas, renewable fuels, and nuclear power in electricity generation. Coal’s 2025 share of generation is reduced from 49 percent in the reference case to 11 percent in the S.139 case. Some reduction in coal use, compared with the reference case, occurs before the start of the S.139 reductions in 2010. These changes occur as the result of anticipatory behavior in the electricity industry, where capacity planning decisions in advance of 2010 are influenced by prospective allowance costs and incentives for early action. The specific results are sensitive to the characterization of technology costs, particularly for carbon dioxide capture and sequestration. They are also sensitive to the availability of natural gas and market acceptance of nuclear power.

Figure S.5. Primary Energy Consumption by Fuel in the Reference and S.139 Cases, 2025 (quadrillion Btu)



Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBASE.D050303A and MLBILL.D050503A.

Natural gas consumption is higher in the S.139 case than in the reference case as a result of greater use of natural gas in the electricity sector. Although more natural gas is used for electricity generation, the increase is relatively small compared to the more significant increase in the use of renewables. The response of the natural gas industry to the increased demand under S.139 is discussed in Chapter 6.

Petroleum use, particularly in the transportation sector, is reduced in the S.139 case. Motor gasoline demand, accounting for 46 percent of total petroleum consumption in 2025 in the reference case, is 13 percent lower in 2025 in the S.139 case than in the reference case. Consumers respond to higher gasoline prices by reducing miles driven and purchasing more efficient vehicles. The bill also provides automobile manufacturers with incentives to supply more efficient vehicles, as discussed in Chapter 4.

Nuclear power, which produces no greenhouse gas emissions, becomes more attractive under the S.139 reduction targets. In the S.139 case, 49 gigawatts of new nuclear capacity is projected to be built by 2025. As a result, the use of nuclear power for electricity generation is projected to be 50 percent higher in the S.139 case than in the reference case.

Consumption of renewable energy, which results in no net greenhouse gas emissions, is projected to be much higher under S.139. Most of the increase is for electricity generation, with additions primarily to biomass and wind generating capacity and more modest additions to geothermal and landfill gas capacity. The share of generation supplied by renewables, including hydropower, increases from 8 percent in 2025 in the reference case to 23 percent in the S.139 case. Steady growth in renewables begins even before the onset of Phase I of S.139 in 2010, due to the early compliance initiatives by generators and increases markedly after 2015, as higher market penetration of renewables reduces their costs and improves their performance over time.

Electricity generation, which accounted for 39 percent of energy-related carbon dioxide emissions in 2001, is significantly lower in the S.139 case than in the reference case. In the S.139 case, electricity sales in 2025 are 11 percent below the reference case projection, with the residential sector showing the largest reduction at 14 percent. Electricity demand in the residential sector shows a greater response to S.139 than does residential natural gas demand, because prices for electricity reflect the cost of emission allowances passed on to electricity consumers, whereas no allowances are required for consumption of natural gas in the residential sector. Consequently, the main impact of S.139 on the residential sector is higher electricity prices, leading to lower consumption of electricity.

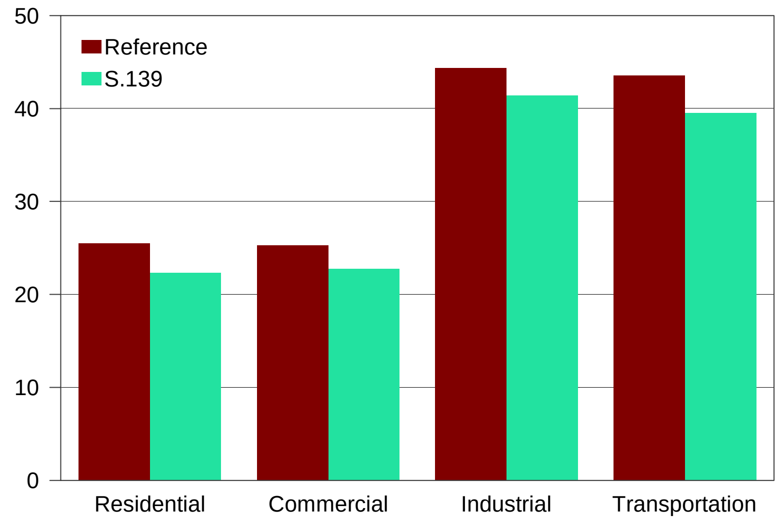
Sectoral Impacts

Energy demand across each of the end-use sectors—residential, commercial, industrial, and transportation—will respond in different degrees to the incentives imposed by S.139 (Figure S.6). Although the bill's definition of covered entities effectively exempts the residential sector and most of the commercial sector from the requirement to purchase greenhouse gas emission allowances, consumers in those sectors still will face higher prices for electricity and natural gas due to S.139. The change in residential and commercial electricity prices reflects the power industry's higher fuel supply costs, allowance costs, and incremental capital costs for lower-emitting generating technologies. The natural gas prices in these sectors reflect the pass-through of higher wellhead prices due to increased demand for natural gas.

In the industrial sector, consumers will face higher prices (including the cost of greenhouse gas allowances) for all fossil fuels and electricity, leading to greater incentives to conserve energy, switch to lower-carbon energy sources, and invest in more energy-efficient technologies. Transportation consumers will also face higher petroleum prices, because the cost of greenhouse gas emission allowances purchased by refiners will be included in prices for motor gasoline, diesel fuel, and jet fuel.

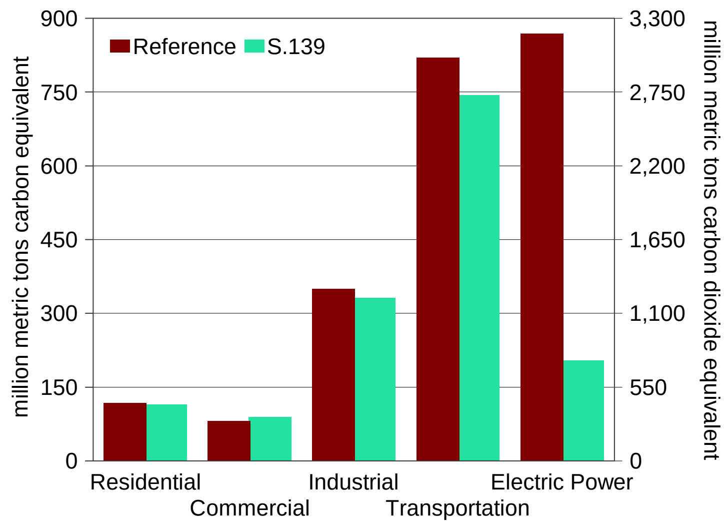
Figure S.7 illustrates the contribution of each sector in reducing energy-related carbon dioxide emissions in 2025 under the S.139 case. When the emissions from electricity are apportioned to the end-use sectors, the residential and commercial sectors account for the greatest reduction, and transportation accounts for the least. As also shown in Figure S.7, most of the carbon dioxide reductions for the four end-use sectors occur in electricity, stemming from both reduced electricity demand and the use of more efficient, less carbon-intensive sources of generation. Reductions in carbon dioxide emissions from electricity generation account for 88 percent of the total energy-related carbon dioxide reductions in 2025. A variety of factors contribute to the central role played by the electricity sector in meeting the greenhouse gas reduction targets: the industry's current dependence on coal; the availability and economics of technologies to switch from coal to less carbon-intensive energy sources; and the comparative economics of fuel switching in other sectors. As discussed in more detail in Chapter 4, the extent to which end-use energy consumers respond to prices is often limited.

Figure S.6. Total Primary Energy Consumption by Sector in the Reference and S.139 Cases, 2025 (quadrillion Btu)



Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBASE.D050303A and MLBILL.D050503A.

Figure S.7. Carbon Dioxide Emissions in the Reference and S.139 Cases by Originating Sector, 2025



Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBASE.D050303A and MLBILL.D050503A.

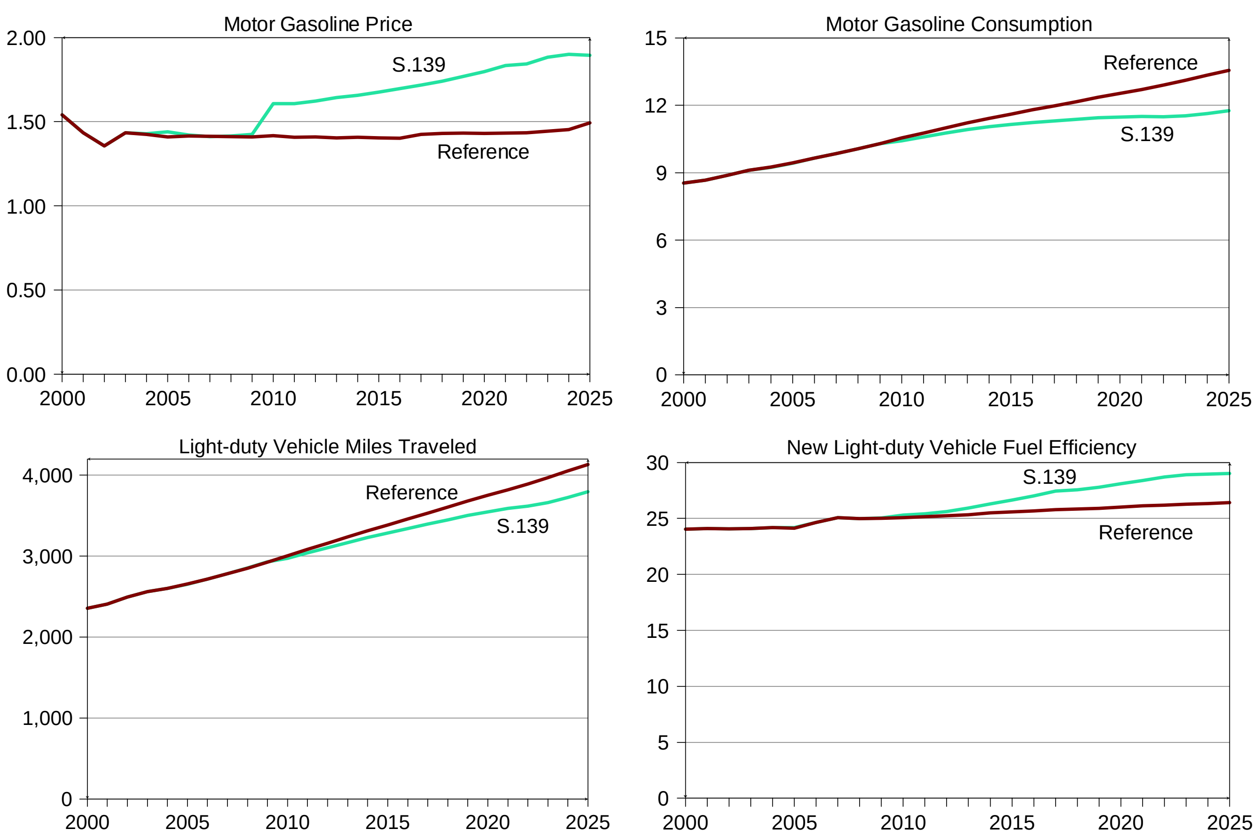
In the industrial sector, some carbon dioxide emission reductions under S.139 can be attributed to reductions in manufacturing output that result from the impact of higher energy prices (including greenhouse gas allowance costs) on the economy. In addition, industrial firms are expected to respond by replacing productive capacity faster, investing in more efficient technology, and switching to less carbon-intensive fuels. Improvements in efficiency are indicated by reductions in energy intensity, as measured by the energy use per dollar of GDP. In 2025, industrial energy intensity is reduced from 4.38 thousand Btu per 1996 dollar of GDP in the reference case to 4.14 thousand Btu per dollar in the S.139 case.

Taking into account fuel switching and efficiency improvements, carbon equivalent emissions per unit of GDP in 2025 for the industrial sector are reduced from 31 kilograms per thousand dollars of GDP in the reference case to 21 kilograms per thousand dollars of GDP in the S.139 case.

Carbon dioxide reductions in the transportation sector occur primarily as the result of reduced travel and the purchase of more efficient vehicles in response to higher energy prices and manufacturer incentives. Compared with the reference case, light-duty vehicle travel (cars, vans, pickup trucks, and sport-utility vehicles) in 2025 is lower by 8 percent in the S.139 case (Figure S.8). At the same time, more efficient cars and light trucks are purchased, raising overall fleet efficiency. By 2025, the average fuel efficiency for the light-duty vehicle fleet is 21.8 miles per gallon under S.139, compared with 20.5 miles per gallon in the reference case. The result of these travel and efficiency changes is a reduction of 13 percent from the reference case level of motor gasoline demand in 2025. Travel reductions and efficiency improvements also occur in the air and freight sectors, further reducing carbon dioxide emissions. Overall, transportation energy consumption in 2025 is 9 percent lower in the S.139 case than in the reference case.

Although the residential sector is exempt from emissions allowances and the commercial sector is assumed not to be covered in the S.139 case, these sectors show significant reductions in electricity-related emissions. Electricity consumers in these sectors are expected to respond to the higher electricity

Figure S.8. Motor Gasoline Consumption and Prices, Light-Duty Vehicle Miles Traveled, and New Light-Duty Vehicle Fuel Efficiency in the Reference and S.139 Cases, 2000-2025



Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBASE.D050303A and MLBILL.D050503A.

prices by taking advantage of appliance rebates or related incentives that the bill provides to reduce its economic impacts.[24] Higher energy prices, particularly for electricity, encourage investments in more efficient equipment and building shells and also reduce the demand for energy services.

In the residential sector, delivered energy use per household in 2025 drops by 7 percent in the S.139 case compared with the reference case. Energy consumption for space conditioning accounts for 35 percent of the total change in residential delivered energy consumption in that year, with lighting accounting for 32 percent of the reduction. Those energy services for which relatively stringent appliance efficiency standards are already in place and for which little opportunity for direct energy conservation measures exist (such as for refrigerators and freezers) are not expected to change greatly under the bill. The current standards for some residential appliances reflect very efficient technology that already reduces fuel consumption substantially in the reference case. The fastest-growing segments of residential electricity consumption, including color televisions, personal computers, and other uses, accounted for approximately 25 percent of residential electricity consumption in 2001. Relative to the reference case, electricity consumption per household in these categories is 7 percent lower in the S.139 case than in the reference case by 2025.

In general, increases in energy costs tend to have a greater percentage impact on lower-income households, because energy expenditures are a higher percentage of their disposable income.[25] The impact on the residential sector from higher energy prices and expenditures could be mitigated by actions of the Corporation. The funds collected by the Corporation from allowance sales can be dispersed to residential energy consumers by various methods, including rebates, subsidies, and general transition assistance to displaced workers. It is assumed in the S.139 case that the Corporation will issue rebates for energy-efficient appliances, and that from 2010 through 2025, half of the incremental cost to purchase more efficient appliances is covered by rebates initiated by the Corporation. (See Chapter 4 for more on this assumption, which is not explicitly defined by the bill but is used as a proxy for potential options that could be used to reduce the economic impact on consumers.) Any funds above those for transition assistance collected by the Corporation and not rebated for appliances are assumed to be rebated to consumers through transfer payments or other rebates. As a result, S.139 has the potential to mitigate the adverse distributional impacts on households.

Because direct emissions in the residential sector are not covered by S.139, households heated primarily by natural gas and home heating oil will be less affected by the bill than those using electricity. This tends to introduce a geographical disparity in the bill's impact on households, in that residences dependent on electric heating tend to be located in regions with a milder climate. Similarly, because the bill is expected to result in higher natural gas prices while reducing heating oil prices somewhat, regions dependent on these fuels will face different outcomes under the bill, based on energy price changes alone.

For this analysis, the impacts on several prototype single-family homes using different fuels were analyzed. For the natural gas home, it is assumed that natural gas is used for space heating, water heating, cooking, and clothes drying. The home using oil for heating is assumed to use electricity for all other energy needs, and the all-electric home is assumed to use only electricity. On average, residents of an all-electric single-family home can expect to pay an average of $257 more per year for energy (in 2001 dollars), a 17 percent increase, in the S.139 case than in the reference case over the 2010 to 2025 period. The natural gas prototype home exhibits the least increase in average expenditures in the period, increasing by $154 per year over the same period, a 10 percent increase over the reference case. Because

[24] See Chapters 2 and 4 for more on the assumptions and effects of appliance efficiency and other programs that could be funded by the Corporation to reduce the economic impacts of the bill.

[25] See Chapter 4 for a summary of data from EIA's Residential Energy Consumption Survey showing how home energy consumption varies by income cohort.

the oil heat prototype home relies on electricity for clothes drying, cooking, and water heating—services that can be provided by natural gas—the average expenditures over the 2010-2025 period increase more than those for the natural gas prototype home, even with lower delivered energy prices in the S.139 case, relative to the reference case. Residents of these homes can expect to pay an average of $169 per year more over the 2010-2025 period, a 9 percent increase over the reference case.

In the commercial sector, direct emissions of carbon dioxide increase slightly in the S.139 case compared to the reference case, as greater use of natural-gas-based combined heat and power is adopted. While this technology increases direct emissions in the commercial sector, overall emissions, including electricity-related emissions, are lower. Overall, delivered energy use per square foot of commercial floorspace in 2025 drops by 2 percent in the S.139 case compared with the reference case. As in the residential sector, significant energy reductions are projected for heating, cooling, and ventilation. However, the largest energy savings come in lighting, offset somewhat by increased use of energy for "other uses," which include such appliances as medical equipment and telecommunications equipment, as well as combined heat and power in commercial buildings. Because of the shift away from purchased electricity to combined heat and power, natural gas use increases in the S.139 case in 2025 compared to the reference case.

The electricity generation sector is expected to respond strongly to the incentives imposed by S.139. The mix of fuels used for electricity generation is projected to change rapidly as new plants come on line. In the aggregate, cumulative investments by generators to reduce carbon dioxide emissions tend to reduce generation from coal and petroleum and to increase the use of renewables, natural gas, and nuclear. Generation from coal, which currently accounts for about half of all electricity, drops significantly as the cost of coal (including allowance costs) to generators increases by a factor of almost 6 in the S.139 case compared to the reference case by 2025. To replace coal plants, generators build natural-gas-fired combined-cycle plants; extend the life of existing nuclear plants and build new ones; increase the use of renewables, particularly biomass and wind energy systems; and build both coal- and natural-gas-fired capacity that includes carbon sequestration technology, which becomes economical once a greenhouse gas emissions target is imposed. These changes, coupled with the expected reduction in electricity demand, result in carbon dioxide emissions from electricity generation of 205 million metric tons carbon equivalent in the S.139 case in 2025, compared with 868 million metric tons carbon equivalent in the reference case. Issues related to plant capacity changes in the electricity industry are discussed in detail in Chapter 5.

Macroeconomic Impacts

S.139 leaves the allocation of available allowances between the Corporation and covered emissions sources to be determined in a future administrative process.[26] It is assumed in the S.139 case that emission allowances are allocated to the Corporation, beginning with 20 percent in 2010 and rising to 80 percent by 2025. The Corporation is assumed to auction the allowances, thereby collecting substantial revenue.

As shown in Figure S.1 above, the allowance price rises steadily through 2023, leveling off as the amount of banked allowances approaches zero. In 2010, the aggregate value of allowances in nominal terms totals $116 billion, with $23 billion flowing to the Corporation from sale of its share of allowances. By 2025, the aggregate nominal value of allowances is $473 billion, with $378 billion flowing to the Corporation. The magnitude of the funds collected, the distribution of the permits between covered entities and the Corporation, and the ultimate use of these funds by the Corporation have impacts on the aggregate economy.

[26] The bill does not specify the share of allowances that would be allocated to the Corporation, leaving this to be determined on an annual basis by the Secretary of Commerce, subject to the approval of Congress.

Under Section 352 of S.139, the Corporation must allocate a percentage of the proceeds from allowances to provide transition assistance to dislocated workers and communities. The percentage is specified to be 20 percent in 2010, reduced by 2 percentage points each year and reaching zero in 2020. The transition assistance amount, however, is a small share of the total allowance proceeds collected by the Corporation. After accounting for the transition assistance, the vast majority of the revenues collected by the Corporation remain to be spent or returned to the economy. As a central assumption of this analysis, the remaining funds are assumed to be transferred back to the consumer as a lump-sum transfer—a rebate check. This refund helps to compensate consumers for higher direct energy costs and higher prices for non-energy goods and services.

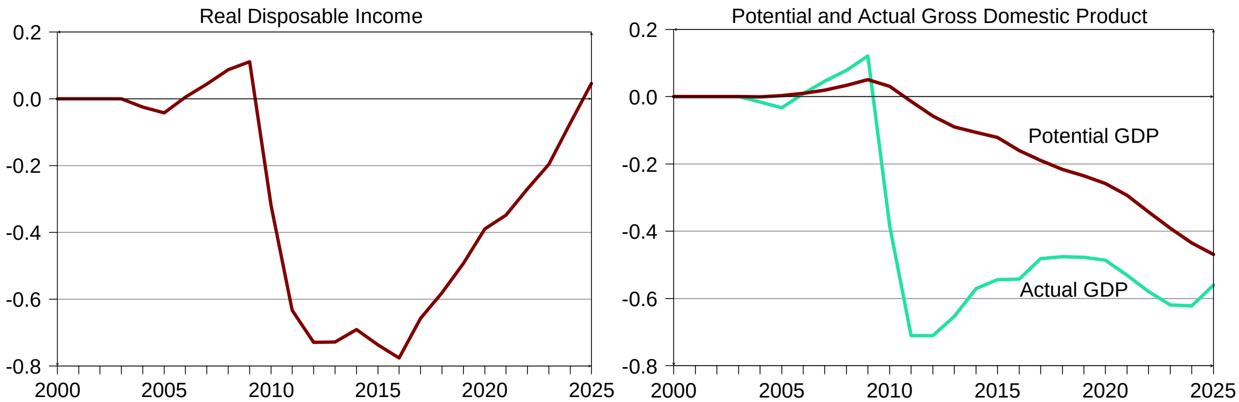
The consumer impacts of the bill are reflected by changes in disposable income (Figure S.9). Initially a low proportion of the funds is allocated to the Corporation, but the proportion increases over the forecast horizon. As the Corporation transfers these rising proceeds to consumers, real disposable income recovers rapidly. From a peak loss of around 0.8 percent ($81 billion in 1996 dollars) in 2016, real disposable income recovers to the reference case level by 2025.

As a consequence of the allowance program, energy prices in the U.S. economy are expected to rise, first driving up the wholesale prices of fuel and power. These price increases raise downstream prices for all goods and services in the economy, as reflected in the wholesale price index (WPI) and the consumer price index (CPI). Relative to the reference case, the WPI for energy is projected to increase in 2010 by 16 percent, the WPI for producer prices by 2.4 percent, and the CPI for goods and services by 0.6 percent. By 2025, the three measures rise by 57 percent, 9.0 percent, and 2.5 percent, respectively, relative to the reference case.

In the long run, higher energy costs reduce the use of energy by shifting production toward less energy-intensive sectors, by replacing energy with labor and capital in specific production processes, and by encouraging energy conservation. Although reflecting a more efficient use of higher-cost energy, this gradual reduction in energy use would tend to lower the productivity of other inputs in the production process. The ultimate impacts of greenhouse gas mitigation policies on the economy will be determined by interactions between elements of aggregate supply and demand and by monetary and fiscal policy decisions. Raising energy prices and, as a result, downstream prices in the rest of the economy is expected to introduce cyclical behavior in the economy, resulting in employment and output losses in the short run. The measurement of losses in output for the economy, or actual GDP, incorporates the transitional cost to the aggregate economy as it adjusts to its long-run path as reflected by potential GDP. Resources may be less than fully employed, and the economy may move in a cyclical fashion toward equilibrium as it adjusts to the initial cause of the disturbance—the increase in energy prices.

The expected interaction between these impacts is summarized in Figure S.9. The graph shows projected losses in potential and actual GDP as a result of S.139. The loss in actual GDP reflects the macroeconomic adjustment cost that is expected to result from higher energy prices as a result of the greenhouse gas mitigation policy. Cyclical adjustments in actual GDP are expected to occur in the short run, but actual GDP eventually converges toward potential GDP by 2025. Actual GDP, which incorporates adjustment costs associated with moving toward a new long-run equilibrium, shows a sharp decline of 0.7 percentage points in 2011 and 2012 (relative to the reference case). Thereafter, the economy begins to rebound from the initial price effects. However, there is a steady negative impact on the long-run supply potential of the economy as all segments adjust to the new pattern of energy use. While the two economic measures merge by 2025 at a loss of 0.6 percent of actual GDP and 0.5 percent of potential GDP, the process of adjustment for both real and potential output has not reached completion by the end of the forecast period.

Figure S.9. Change in Real Disposable Income, Potential GDP, and Actual GDP in the S.139 Case Relative to the Reference Case (percent)



Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBASE.D050303A and MLBILL.D050503A.

Given projected 2025 GDP in the reference case of $18.9 trillion (1996 dollars), the estimated losses in actual and potential GDP are large in dollar terms—$106 billion and $90 billion, respectively, with even larger cumulative impacts (Table S.3). However, the compounded GDP growth rates from 2001 to 2025 are virtually identical in the two cases: 3.04 percent per year in the reference case and 3.02 percent per year in the S.139 case. This suggests that the uncertainty in growth patterns related to other factors that drive the U.S. economy, such as labor force and productivity growth, are likely to play a larger role than decisions regarding the enactment of S.139 in determining the size of the U.S. economy in 2025.

Table S.3. Economic Impacts of S.139 (billion 1996 dollars and percent change relative to the reference case)

	Actual GDP	Potential GDP
Cumulative GDP Loss, 2004-2025 (billion 1996 dollars)		
Undiscounted	-1,354	-559
Discounted at 7 Percent per Year	-507	-165
Percent Change from Reference Case		
Undiscounted	-0.4%	-0.2%
Discounted at 7 Percent per Year	-0.3%	-0.1%
Economic Impact, 2025		
GDP Loss (billion 1996 dollars)	-106	-90
Percent Change from Reference Case	-0.6%	-0.5%

Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBASE.D050303A and MLBILL.D050503A.

Sensitivity Analyses

Long-term economic projections are highly uncertain in general, and even more so when legislation with the complexity of S.139 is being analyzed. One area of uncertainty is the growth in emissions that might occur in the bill's absence. The baseline forecast used affects the amount of change needed to meet an emission target, as do the modeling methodologies and assumptions. Issues regarding availability of low carbon emitting technologies and offsets from emissions other than carbon dioxide and from international sources affect the ability to comply with S.139 and the feasibility of the analytical results. Estimation of GWPs and historical emissions for non-energy-related greenhouse gases, while currently the best available, can still benefit from improved methodologies. Factors that influence the future development of energy markets, including technology development and resource availability and costs, also affect the results. Sensitivity cases were analyzed to evaluate the uncertainties. Other uncertainties, such as the potential for political and economic disruptions, are also important but are beyond the scope of this analysis.

Some of the sensitivity cases discussed below were designed to examine uncertainties particular to the proposed legislation, as well as the impact of some of its flexibility features.[27] Additional cases examine key technology assumptions and energy supply issues. The results of the sensitivity cases are summarized below.

High Technology Sensitivity Cases

The cost and performance of emerging technologies useful in reducing energy use or its greenhouse gas intensity are among the most important factors affecting the evaluation of S.139 impacts. Using the assumptions of the *AEO2003* high technology case for the four end-use sectors and the electric power sector, a high technology reference case and a high technology variation of the S.139 case were prepared. Assumptions in the high technology cases vary by sector but generally include earlier availability, lower costs, and higher efficiencies for advanced technologies than in the reference case.

Table S.4 provides key results that can be used to show how assumptions about the state of energy-related technology affect the impacts of S.139. Energy-related carbon dioxide emissions in the high technology reference case are 8 percent lower in 2025 than in the standard reference case. The smaller reduction in carbon dioxide emissions needed to comply with S.139 reduces the estimated allowance price in the S.139 high technology case in 2025 by 28 percent relative to its level in the S.139 case.

Two alternative comparisons can be used to gauge the economic effects of S.139 under high technology assumptions. The first, which focuses on the change in economic performance between the high technology reference case and the S.139 high technology case, implicitly assumes that the enactment of S.139 does not affect the set of available technologies, only what and how much is chosen from that set. Using this comparison, S.139 reduces accumulated actual GDP over the modeled 2004-2025 time frame by $1.035 trillion[28] (0.33 percent). In 2025, when the transition to the S.139 regime is largely complete, the overall size of the economy is reduced by $95 billion (0.50 percent).

Alternatively, economic performance in the S.139 high technology case and the standard reference case can be compared. This comparison implicitly assumes that S.139 is directly responsible for creating technologies with the cost and performance characteristics of EIA's high technology suite, which would not be available in its absence. Using this approach, S.139 reduces accumulated actual GDP over the modeled 2004-2025 time frame by $971 billion (0.31 percent). In 2025, the overall size of the economy is reduced by $94 billion (0.50 percent).

---

[27] These cases are presented in response to the requests made by the solicitors of the analysis.
[28] GDP and disposable income values in this section are in 1996 dollars.

Table S.4. Comparison of Key Results in the Reference and High Technology Sensitivity Cases, 2010 and 2025

	2010				2025			
	Reference	High Technology Reference	S.139	S.139 High Technology	Reference	High Technology Reference	S.139	S.139 High Technology
Greenhouse Gas Emission Allowance Price (2001 dollars per metric ton carbon equivalent)	—	—	79	59	—	—	221	158
Electricity Price (2001 cents per kilowatthour)	6.40	6.29	6.96	6.71	6.71	6.25	9.79	8.57
Electricity Sales (billion kilowatthours)	4,104	4,020	4,050	3,965	5,246	4,997	4,653	4,481
Cumulative Incremental[a] Capacity Additions (gigawatts)								
Coal	12	9	0	0	81	60	38	18
Natural Gas Combined Cycle	32	30	60	51	162	183	260	262
Combustion Turbine/Diesel	9	4	4	1	52	17	4	1
Nuclear Power	0	0	0	0	0	0	49	41
Renewables	1	3	33	25	5	11	148	110
Distributed Generation	2	1	2	1	18	8	5	2
Total Additions	**57**	**47**	**98**	**77**	**318**	**280**	**503**	**433**
Energy Consumption (quadrillion Btu)								
Coal	25.47	24.85	22.00	22.47	29.86	26.89	6.74	8.00
Natural Gas	27.35	26.62	28.12	26.82	35.55	32.35	39.54	36.44
Petroleum	44.45	43.82	43.74	43.30	56.11	53.29	50.76	49.41
Nuclear	8.25	8.17	8.37	8.37	8.28	8.05	12.39	11.76
Renewable	7.30	7.71	9.03	9.03	8.77	10.28	16.22	15.60
Electricity Imports	0.31	0.27	0.43	0.41	0.06	0.05	0.32	0.11
Total	**113.13**	**111.44**	**111.67**	**110.39**	**138.63**	**130.90**	**125.97**	**121.31**
Carbon Dioxide Emissions by Fuel								
Coal	650	634	560	573	763	687	119	182
Natural Gas	391	381	402	383	509	463	493	451
Petroleum	761	750	748	740	963	911	870	844
Total	**1,802**	**1,764**	**1,710**	**1,696**	**2,234**	**2,060**	**1,482**	**1,477**

[a] Excludes plants under construction.

Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBASE.D050303A, MLBASE_HT.D052003C, MLBILL.D050503A, ML_HT.D050503A.

Analytical judgment and a recognition of inherent modeling limitations are needed to assess which approach is most likely to reflect the actual impact of "high technology" on the economic assessment of S.139. The major effect that S.139 has on delivered energy prices suggests that it should provide some incentive to research and develop new technologies to increase energy efficiency or reduce greenhouse gas intensity. If so, the first approach (comparison of two high technology cases) could overstate adverse economic impacts.

On the other hand, the second approach (comparison of the S.139 high technology case to the standard reference case) does not consider the cost of researching and developing new technologies. Moreover, NEMS does not explicitly represent the role of non-energy-related research and development (R&D) activities in supporting the baseline scenario of economic growth in its macroeconomic component. Therefore, NEMS cannot represent the macroeconomic impact of diverting R&D effort away from other sectors toward energy-related technologies. Such shifts in R&D effort would erode baseline growth to the extent that scarce R&D resources and technological progress in other areas of the economy were reduced.[29]

The analysis of these effects continues to be an active area of academic research. Based on its reading of the available literature, EIA's view is that the first approach is most likely to provide estimates of economic impacts that are closest to the actual economic effects under a high technology scenario.

A separate issue related to technology is the possibility that one or more technologies superior to those identified in the "high technology" case could become available within the time frame of this analysis. While the high technology case assumptions are optimistic by design, there is always a potential for undiscovered or unanticipated technological developments to occur. The contribution of such technologies within the time frame of this analysis is likely to be limited by delays that often arise in the market penetration of new energy technologies, particularly when the new technologies are not readily compatible with the existing infrastructure.

No New Nuclear/No Sequestration Sensitivity Case

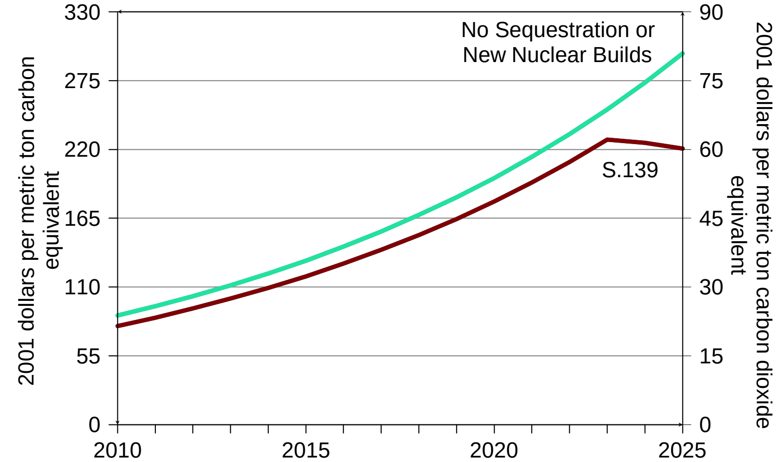
In the S.139 case, two of the key compliance strategies projected to be adopted in the electric power sector are geological carbon sequestration and advanced nuclear power. A sensitivity case, the no new nuclear/no sequestration case, was used to examine the results if neither of these technologies became competitively available by 2025. The estimated allowance prices for this sensitivity case (Figure S.10) are significantly higher than those in the S.139 case (34 percent higher in 2025), resulting in electricity prices that are 9 percent higher than those in the S.139 case in 2025. Without these technologies, the electricity sector is expected to rely more heavily on other low-emission technologies, particularly biomass, which substitutes for the baseload technologies no longer available. The electricity sector still remains the principal source of emissions reductions among the energy sectors. Table S.5 compares key results from the reference, S.139, and no new nuclear/no sequestration cases.

High Natural Gas Price Sensitivity Cases

Another area of uncertainty concerns technology advances and the resource costs of energy supply. Recently, much public attention has been focused on natural gas availability, with some analysts suggesting that EIA's *AEO2003* reference case was too optimistic about the prospects for meeting significant growth in the demand for natural gas with the average wellhead price remaining below $4 per million Btu (2001 dollars) through 2025. Because fuel switching to natural gas is expected to be a key strategy for compliance with S.139, it is important to examine how a more pessimistic assessment of

[29] This result would hold even with some net increase in total R&D activity

Figure S.10. Projected Allowance Prices in the S.139 and No New Nuclear/No Sequestration Cases, 2010-2025



Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBILL.D050503A and ML0NUCSEQ.D050403A.

Table S.5. Comparison of Key Results in the Reference, S.139, and No New Nuclear/No Sequestration Cases, 2025

	2025		
	Reference	**S.139**	**No New Nuclear / No Sequestration**
Cumulative Incremental[a] Capacity Additions (gigawatts)			
Coal	81	38	0
Natural Gas Combined Cycle	162	260	249
Combustion Turbine/Diesel	52	4	3
Nuclear Power	0	49	0
Renewables	5	148	206
Distributed Generation	18	5	6
Total Additions	**318**	**503**	**464**
Greenhouse Gas Emission Allowance Price			
(2001 dollars per metric ton carbon equivalent)	—	221	297
(2001 dollars per ton metric carbon dioxide equivalent)	—	*60*	*81*
Electricity Price (2001 cents per kilowatthour)	6.71	9.79	10.68
Electricity Sales (billion kilowatthours)	5,246	4,653	4,573
Carbon Dioxide Emissions by Fuel (million metric tons carbon equivalent)			
Coal	763	119	93
Natural Gas	509	493	582
Petroleum	963	870	859
Total	**2,234**	**1,482**	**1,534[b]**

[a] Excludes plants under construction.
[b] Total emissions are higher in this case than in the S.139 case, because previously banked allowances are still available to be used in 2025. In the S.139 case, the bank of allowances is depleted in 2023.
Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBASE.D050303A, MLBILL.D050503A, and ML0NUCSEQ.D050403A.

natural gas availability would affect the estimated impacts of S.139. Accordingly, a sensitivity case was developed assuming higher natural gas prices, more pessimistic assumptions for recoverable reserves and undiscovered resources, and limited alternative sources of supply.

Applying these assumptions in the reference case results in 40 percent higher wellhead prices in 2025. Applying the same assumptions in the S.139 case further increases natural gas prices and changes the mix of compliance strategies, particularly in the electricity sector. However, the overall cost of compliance, as indicated by the allowance prices, increases by no more than 6 percent from that in the S.139 case over the projection period. In the electricity sector, plant capacity substituted for natural gas additions includes coal with carbon sequestration, nuclear, and renewables (Table S.6). As a result, overall coal consumption in this sensitivity case is 238 million tons higher than in the S.139 case but, at 543 million tons, significantly lower than the 1,466 million tons projected in the reference case.

Allowance Allocation Sensitivity Cases

Two alternative allocation schemes were analyzed as sensitivity cases. The first case (corp20) holds the percentage allocated to the Corporation steady at 20 percent from 2010 to 2025; the second case (corp80) holds the Corporation share at 80 percent from 2010 through 2025. These sensitivity cases primarily influence the funds available to the Corporation from the sale of allowances, which are distributed to consumers to reduce the overall economic impact of the bill.[30] The two allocation sensitivity cases affect the cost of compliance, as revealed in the macroeconomic effects of the consumer rebate. There is no significant variation in allowance prices among the three cases.

Under the S.139 case, the funds (in nominal dollars) allocated to the Corporation rise from $23 billion in 2010 to $378 billion in 2025. In the corp20 sensitivity case, the funds also start at $23 billion but rise to only $93 billion in 2025, $285 billion less than in the S.139 case. In the corp80 case, the funds start at $94 billion and rise to $391 billion in 2025, $13 billion higher than in the S.139 case. The change in allocation of permits affects both the magnitude and the time profile of the economic impacts.

Figure S.11 compares real disposable income and actual GDP among the three cases. The S.139 case follows the corp20 case in the first few years but then begins to diverge as the S.139 case channels more funds back to the consumer when permits allocated to the Corporation continue to increase. By 2025, real disposable income in the S.139 case approximately matches that in the corp80 case; however, actual GDP in the S.139 case recovers more rapidly than in either of the sensitivity cases, and the negative effect on actual GDP is smaller. The difference lies in how the various cases affect consumption and investment, both in the short term and in the long term. By returning a greater amount of funds to consumers, the corp80 case leads to greater consumption, helping to moderate near-term impacts on the economy. The corp20 case generates a greater amount of investment, and toward the end of the forecast period boosts both potential and actual GDP. The S.139 case, which assumes an increasing rate of allowance allocations to the Coroporation over time, leads to the smallest long-term loss in actual GDP. The S.139 case differs fundamentally from the two sensitivity cases, because consumers see a steady improvement in disposable income and other factors over time, leading to a faster recovery than in the other two cases. Consumers are influenced not only by the amount of funds available to be spent, but also by expectations about the future.

Commercial Coverage Sensitivity Case

Under S.139, entities in the commercial sector would be covered by the allowance program if their annual greenhouse gas emissions were over 10,000 metric tons carbon dioxide equivalent. As discussed in Chapter 2, there are no data sources adequate to determine the extent of coverage in the commercial sector. Because rough estimates indicate that coverage of the commercial sector would be small, the

[30] Some of the funds are used as rebates to buy down the cost of efficient appliances.

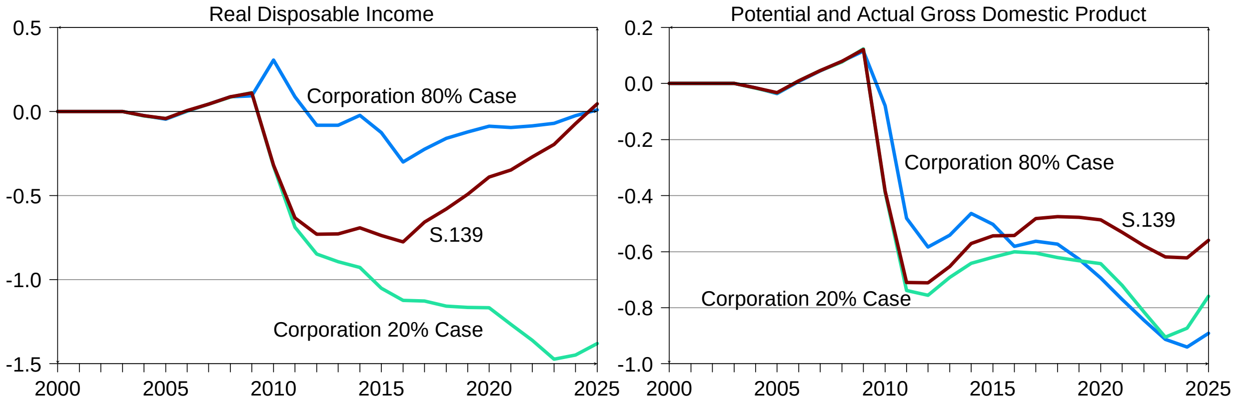
Table S.6. Comparison of Key Results in the Reference, S.139, and High Natural Gas Price Sensitivity Cases, 2010 and 2025

	2010				2025			
	Reference	S.139	High Natural Gas Price Reference	S.139 High Natural Gas Price	Reference	S.139	High Natural Gas Price Reference	S.139 High Natural Gas Price
Greenhouse Gas Emission Allowance Price (2001 dollars per metric ton carbon equivalent)	—	79	—	83	—	221	—	214
Natural Gas Wellhead Price (2001 dollars per thousand cubic feet)	3.39	3.51	3.81	3.86	3.95	4.36	5.55	5.70
Electricity Price (2001 cents per kilowatthour)	6.40	6.96	6.55	7.12	6.71	9.79	7.18	10.28
Electricity Sales (billion kilowatthours)	4,104	4,050	4,089	4,032	5,246	4,653	5,202	4,617
Cumulative Incremental[a] Capacity Additions (gigawatts)								
Coal	12	0	13	0	81	38	144	81
Natural Gas Combined Cycle	32	60	28	47	162	260	108	177
Combustion Turbine/Diesel	9	4	10	3	52	4	45	4
Nuclear Power	0	0	0	0	0	49	0	65
Renewables	1	33	2	41	5	148	7	178
Distributed Generation	2	2	2	1	18	5	16	4
Total Additions	**57**	**98**	**54**	**93**	**318**	**503**	**321**	**509**
Energy Consumption (quadrillion Btu)								
Coal	25.5	22.0	25.6	22.6	29.9	6.7	33.1	11.9
Natural Gas	27.3	28.1	26.6	27.0	35.5	39.5	30.1	30.5
Petroleum	44.4	43.7	44.5	43.7	56.1	50.8	57.1	51.3
Nuclear	8.2	8.4	8.2	8.4	8.3	12.4	8.3	13.7
Renewable	7.3	9.0	7.3	9.3	8.8	16.2	8.8	18.0
Electricity Imports	0.3	0.4	0.3	0.5	0.1	0.3	0.1	0.4
Total	**113.1**	**111.7**	**112.6**	**111.4**	**138.6**	**126.0**	**137.5**	**125.8**
Carbon Dioxide Emissions by Fuel (million metric tons carbon equivalent)								
Coal	650	560	652	577	763	119	846	192
Natural Gas	391	402	381	385	509	493	430	403
Petroleum	761	748	763	747	963	870	984	879
Total	**1,802**	**1,710**	**1,796**	**1,709**	**2,234**	**1,482**	**2,260**	**1,474**

[a] Excludes plants under construction.

Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBASE.D050303A, MLBILL.D050503A, MLBASE_HGP.D052103A, and MLBILL_HGP.D052303A.

Figure S.11. Changes in Real Disposable Income and Actual Gross Domestic Product Relative to the Reference Case in the S.139 and Two Allowance Allocation Sensitivity Cases, 2000-2025 (percent)



Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBILL.D050503A, ML_CCCC80.D050503A, and ML_CCCC20.D050503A.

S.139 case assumed no coverage in the commercial sector. A sensitivity case was analyzed to examine the effect of including all commercial sector entities under the bill's coverage.

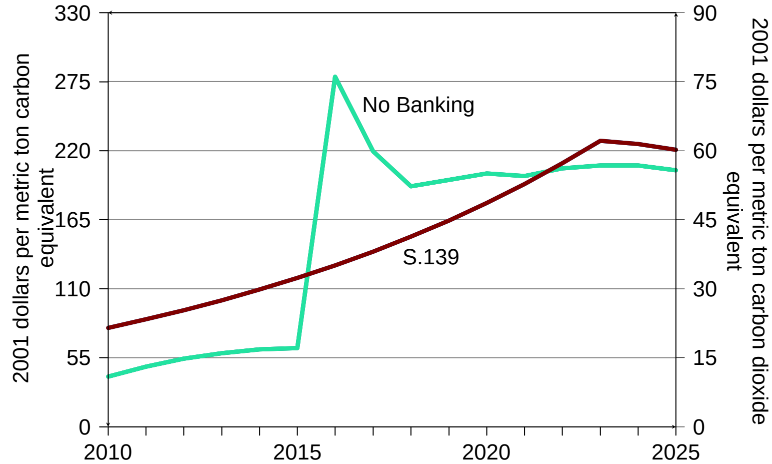
Including the commercial sector does not have a major impact on the results, because direct carbon dioxide emissions in the commercial sector make up only about 4 percent of total energy-related carbon dioxide emissions. Most of the energy used in the commercial sector is in the form of purchased electricity, which already is subject to higher prices in the S.139 case. The principal energy market effect of the commercial coverage sensitivity case is substitution of natural gas in the electricity sector for natural gas in the commercial sector. Most of the projected commercial sector additions to natural-gas-based combined heat and power capacity in the S.139 case (driven by higher electricity prices) are replaced by additions of combined-cycle capacity in the electric power sector in the commercial coverage sensitivity case.

No Banking Sensitivity Case

The allowance banking provision of S.139 provides entities with considerable flexibility in meeting allowance requirements. Because the second compliance phase reduces the allowances to 1990 emission levels, compliance is more difficult than in Phase I, which is based on 2000 emission levels. Allowing covered entities to overcomply in Phase I smoothes the transition to Phase II. As a result, the banking provision of S.139 is expected to result in steady, rather than sudden, growth in allowance prices from Phase I to Phase II.

A no banking sensitivity case was examined to assess the economic implications of the banking provision. This case requires that allowances must be used in the year in which they are issued, while retaining the Phase I and Phase II allowance totals. This case results in a time profile of allowances prices significantly different from that in the S.139 case (Figure S.12). Allowance prices in the no banking case are lower in Phase I, but there is a large jump in 2016, followed by a gradual return to the levels in the S.139 case.

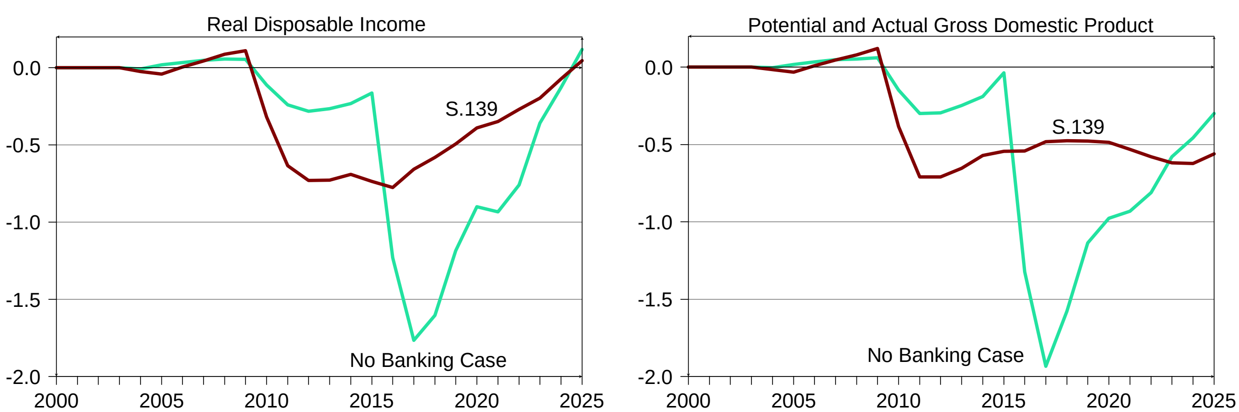
Figure S.12. Allowance Prices in the S.139 and No Banking Cases, 2010-2025



Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBILL.D050503A and ML_NOBANK_4.D051203A.

Figure S.13 compares the impacts on real disposable income and actual GDP in the S.139 case and the no banking sensitivity case. Through 2015, disposable income and actual GDP both decline by less in the sensitivity case than in the S.139 case. In 2016, however, energy prices rise sharply in response to the rise in the allowance price. Actual GDP and disposable income both decline sharply, reaching a peak loss in 2017, with actual GDP 1.9 percent lower and disposable income 1.8 percent lower than in the reference case. Thereafter, both recover rapidly as a result of a both sharp drop in energy prices as the allowance price declines and a large increase in the amount of funds distributed back to consumers and used for transition assistance in the post-2015 period.

Figure S.13. Changes in Real Disposable Income and Actual Gross Domestic Product in the S.139 and No Banking Cases Relative to the Reference Case (percent)



Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBASE.D050303A, MLBILL.D050503A, and ML_NOBANK_4.D051203A.

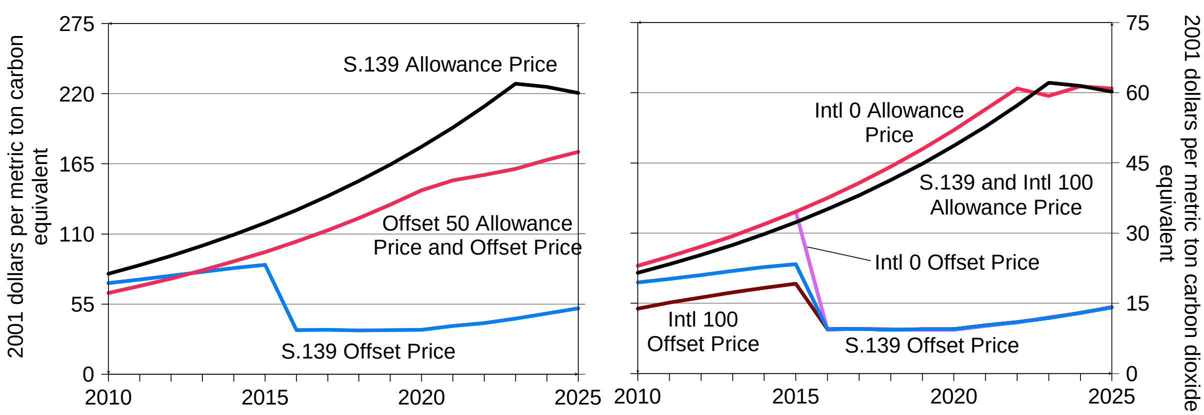
Offset Sensitivity Cases

Several sensitivity cases were used to examine the issue of compliance offsets. Covered entities may use offset credits from several sources, subject to an overall cap specified in S.139. The potential sources of offsets include registered reductions from noncovered entities, registered increases in biological carbon sequestration, and emission allowances from other countries. In one sensitivity case (offset50), the offset limit was increased to 50 percent. Two other cases were examined to test assumptions regarding the availability and costs of international emissions offsets (discussed in Chapter 3). In one case (intl100), the assumed supply curve of offsets from international sources was doubled. A second case (intl0) assumed that no international offsets would be available.

Figure S.14 compares the market-clearing prices for allowances and offsets in the three offset sensitivity cases with those in the S.139 case. In the offset50 case, the limit on offsets is not reached, and the trading prices of offsets and allowances are identical, at levels below the S.139 case. Table S.7 summarizes the energy market outcomes in the offset sensitivity cases. Because the offset50 case effectively reduces the amount of emissions reductions in the covered sectors, the magnitude of changes in the energy sectors to comply with S.139 is reduced. As a result, there is greater coal use and a reduced reliance on renewable, nuclear, and carbon sequestration in the electricity sector in the offset50 case.

In the intl100 case, the Phase I and Phase II limits on offsets are the same as in the S.139 case. As a result, the primary effect of this case is to alter the mix of offsets available from the three offset sources, increasing the international share relative to the domestic share. In the intl0 case, the unavailability of international offsets raises the offset price to equal the allowance price in Phase I, and the allowance price clears at a level above that in the S.139 case.[31] The unavailability of offsets in the intl0 case affects only the Phase I offset prices, which increase by a maximum of 48 percent in 2015 relative to the S.139 case. Figure S.15 compares the mix of offsets for 2010, 2016, and 2025 in the intl0, intl100, and S.139 cases. In the intl100 case, the lower price of international offsets is insufficient to make them competitive with domestic offsets in Phase II, and no international offsets penetrate. However, the Phase I offset prices are lower, and more international offsets are included in the mix.

Figure S.14. Comparison of Allowance and Offset Prices in the S.139 and Offset Sensitivity Cases, 2010-2025



Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBILL.D050503A, ML_INTL100.D052703A, and ML_INTL0.D051903A.

[31] The exception is in 2023, as the allowance bank is depleted one year earlier in the intl0 case than in the S.139 case, and the price temporarily drops in the following year.

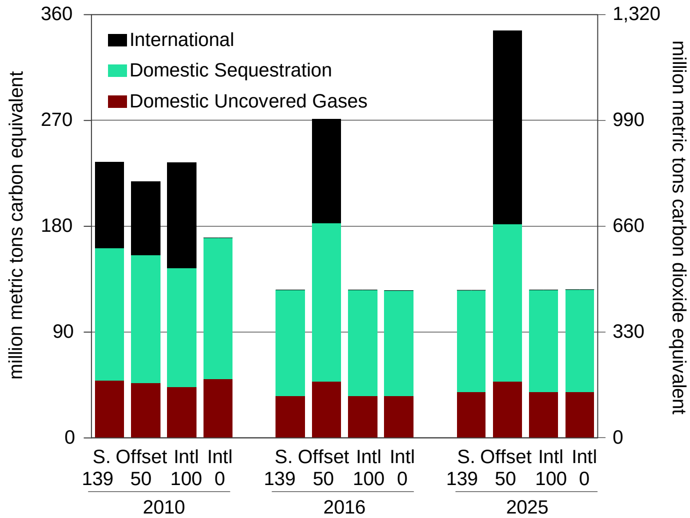
Under S.139, some emissions allowances would be distributed to covered entities, and some would be allocated to the Corporation to auction or otherwise sell in the emissions allowance market. The bill does not specify the allocation shares. For the S.139 case, our initial analysis assumed that in 2010, 80 percent of the allowances would be distributed to covered entities, and that the share would increase linearly each year to 20 percent in 2025. The rest of the allowances are allocated to the Corporation.

Table S.7. Comparison of Compliance Results in the S.139 and Offset Sensitivity Cases, 2010 and 2025 (million metric tons carbon equivalent)

	2010				2025			
	S.139	OFFSET 50	INTL 100	INTL 0	S.139	OFFSET 50	INTL 100	INTL 0
Greenhouse Gas Emissions								
Energy-Related Carbon Dioxide	1,710	1,737	1,710	1,704	1,482	1,697	1,482	1,482
Non-Energy Carbon Dioxide	40	40	40	40	46	46	46	46
Methane	115	117	120	114	120	111	120	120
Nitrous Oxide	121	121	121	121	137	137	137	137
High GWP Gases (HFCs, PFCs, and SF_6)	50	51	50	50	106	106	106	106
Total	**2,036**	**2,066**	**2,041**	**2,028**	**1,891**	**2,098**	**1,891**	**1,891**
S.139 Compliance Summary								
Covered Energy-Related CO_2	1,513	1,540	1,513	1,507	1,257	1,475	1,256	1,256
Other Covered GHG Emissions	70	71	70	70	128	128	128	128
Total Covered Emissions	**1,583**	**1,611**	**1,583**	**1,577**	**1,385**	**1,603**	**1,384**	**1,384**
Offset Reductions Purchased								
Noncovered Greenhouse Gases	49	47	43	50	39	48	39	39
Increases in Biological Carbon Sequestration	113	108	101	120	87	134	87	87
International Offsets	73	63	90	0	0	165	0	0
Total Offset Reductions	**235**	**218**	**234**	**170**	**126**	**346**	**126**	**126**
Covered Emissions, Less Offsets	1,349	1,393	1,349	1,407	1,259	1,256	1,258	1,258
Emission Allowances Issued	1,465	1,465	1,465	1,465	1,258	1,258	1,258	1,258
Allowance Bank Change (+, deposit; -, withdrawal)	+117	+72	+116	+58	-1	+1	0	0
Greenhouse Gas Emission Allowance Price								
(2001 dollars per metric ton carbon equivalent)	79	64	79	84	221	174	222	223
(2001 dollars per metric ton carbon dioxide equivalent)	*22*	*17*	*22*	*23*	*60*	*48*	*60*	*61*
Offset Trading Price								
(2001 dollars per metric ton carbon equivalent)	71	64	51	84	52	174	52	52
(2001 dollars per metric ton carbon dioxide equivalent)	*19*	*17*	*14*	*23*	*14*	*48*	*14*	*14*

Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBILL.D050503A, OFFSET50.D052303A, ML_INTL100.D052703A, and ML_INTL0.D051903A.

Figure S.15. Mix of Offset Compliance Sources in the S.139 and Offset Sensitivity Cases, 2010, 2016, and 2025



Source: Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBILL.D050503A, OFFSET50.D052303A, ML_INTL100.D052703A, and ML_INTL0.D051903A.

Other Issues Addressed in the Report

Tax Versus Cap and Trade Program

In his request for an analysis of S.139, Senator Inhofe asked EIA to address the differences between S.139 and an equivalent greenhouse gas emission tax. An emissions tax could have advantages in terms of lower administrative costs, while providing greater certainty to emitters on the future cost of emitting greenhouse gases. Theoretically, it would be possible to specify an emissions tax that yields the same results as an allowance cap and trade system. In practice, however, the tax would have to be determined in advance such that it yielded the desired emissions reductions. Both programs are economically efficient in terms of assigning the compliance costs based on the quantity of emissions.

A primary distinction between a tax and a cap and trade system could be in distributional impacts, depending on the distribution of allowances. Under an allowance program where emissions rights are auctioned, the distributional impacts would be the same as for an emissions tax. However, if some or all the allowances are allocated for free, a redistribution of income occurs in favor of the allowance recipients.

A secondary difference could result if the allowance program and the tax applied to different segments of the economy. For example, the S.139 allowance program applies only to entities with emissions above a threshold. A tax system applied to fuels at the supplier level might more easily be applied broadly across all emissions sources (for example, for fossil fuels), compared to an allowance program, which may only be practical to administer for larger emission sources. A more detailed discussion of these issues is provided in Chapter 7.

International Sector Greenhouse Gas Activities and Their Relation to S.139

Senator James Inhofe requested that EIA provide information on the greenhouse gas commitments currently adopted by China, Mexico, South Korea, India, and Brazil.[32] These countries have ratified the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. Each of the five nations' governments has established an entity to coordinate climate change activities in the country. The five countries may also participate in the Kyoto Protocol through the Clean Development Mechanism (CDM), which enables entities in Annex I countries to acquire emission reductions generated in developing countries. In addition, all five countries have introduced specific initiatives to address climate change. However, none of the countries have adopted enforceable greenhouse gas emission targets. Based on S.139 criteria, they would be ineligible to provide allowances to covered entities as offsets. This topic is discussed more fully in Chapter 3.

Additional Context for the Report

Uncertainties

As with any mid- to long-term forecast there is considerable uncertainty surrounding the projections in this analysis. Reducing greenhouse gas emissions is expected to lead to significant increases in the use of energy production technologies that emit no (or low levels of) greenhouse gases, as well as more efficient energy consumption technologies. Currently, many of these technologies are not used or play fairly small roles in energy consumption and production. As a result, their potential cost and performance are relatively unknown. Alternative assumptions about the cost, performance, and market acceptance of these technologies could lead to different analysis results. Other key uncertainties include assumptions about the ways in which greenhouse gas emission allowances are distributed to covered entities, the availability of international offsets, and the degree to which covered entities will be allowed to purchase allowances in the international market. Nor does the analysis include any expectation about how S.139 might be amended based on application experience, or what limitations might be placed on greenhouse gas emissions.

Modeling Considerations

NEMS has many qualities, such as its technology representation, that make it a useful tool for analyzing the energy system and economic impacts of S.139. The high degree of energy detail within NEMS allows it to trace important energy linkages that would be difficult, if not impossible, to understand using models that represent the energy sector at a higher level of abstraction. The NEMS model forecasts to 2025. Capacity expansion decisions in the electricity generation sector and for combined heat and power production are based on expectations of fuel costs, capital and operating costs, and allowance prices over the next 20 years, assuming that the greenhouse gas targets and allowance prices remain at 2025 levels. NEMS does not address the impact of S.139 in the post-2025 period for the other sectors. While alternative modeling frameworks exist that provide different forecast horizons, those that extend beyond 2025 tend to limit the technological detail that is important in analyzing proposed legislation such as S.139. Many sensitivity cases are included in this analysis to address uncertainties in the modeling framework and assumptions; however, it is impossible to cover the full spectrum of possibilities with the time and resources available.

---

[32] See Appendix A for a copy of the January 28, 2003, letter from Senator Inhofe to EIA.

Comparison With Other Modeling Results

Although the ideas behind S.139 have been widely discussed for some time within the environmental and energy policy community, S.139 is a new piece of legislation. There has been considerable discussion and speculation regarding its likely economic and energy impacts, but there are not yet many detailed studies with which the results obtained in this report can be compared or contrasted. One study to which the findings in this report might usefully be compared was recently issued by researchers at the Massachusetts Institute of Technology (MIT) in June 2003.[33] As might be expected, given the uncertainties and differences in modeling approaches, the results are similar in some areas but different in others.

The emissions allowance price is one key point of comparison across studies, because it adds directly to the cost of all fossil fuels used in the covered sectors (electricity generation, industry, and transportation) and also directly affects the price of electricity to consumers in all sectors. Table S.8 compares allowance prices from the MIT study's "scenario 7"—the scenario that incorporates the greenhouse emissions targets and offset limitations specified in S.139—with allowance prices in the S.139 and high technology S.139 cases of this analysis. Both the allowance prices and their temporal pattern are quite similar across the two studies.

Some important differences between the energy results from the MIT study and the present analysis also merit attention. In part these arise from differences in energy baselines before consideration of the effects of S.139 (Table S.8). The MIT baseline shows much higher use of coal and much lower use of natural gas than the EIA baseline. The MIT oil baseline also grows at a much slower rate than the EIA baseline.

Although the allowance prices are similar in the two studies, the nature and magnitude of the changes in energy mix in response to S.139 diverge significantly. Table S.8 summarizes oil consumption changes in response to S.139. Because two-thirds of all oil is used in the transportation sector and the use of oil for heating in the residential and commercial sector is not covered by S.139, the transportation sector is the focus of attention. Relatively small changes in the end-use price of petroleum fuels (changes that are smaller than the reported allowance value in cents per gallon, because both models assume that the world oil market price falls as demand is reduced) cause much larger changes in oil consumption in the MIT model than in the EIA model.

Changes in coal and natural gas demand also vary widely between the MIT and EIA analyses. The MIT study reports a significant reduction in coal consumption from the baseline level; in 2020, the MIT study reports 35 percent lower coal consumption than in the baseline projection, but the resulting level of coal consumption in 2020 is only 8 percent lower coal consumption in 2000. In EIA's S.139 case, coal consumption is projected to be 63 percent below the reference case level in 2020—55 percent below the 2000 level. In the MIT study, natural gas use is projected to increase by 14 percent between 2000 and 2020 in that study's S.139 scenario. In EIA's S.139 case, natural gas consumption is projected to increase by 53 percent between 2000 and 2020.

One explanation for the smaller amount of fuel switching between the MIT baseline and policy cases than between the EIA reference and S.139 cases is that the MIT results incorporate a larger reduction in total energy use between the baseline and policy cases. In 2020, the last year for which the results can be compared, EIA's analysis projects a 15.5 percent reduction in total energy use, compared with 19 percent in the MIT study. The percentage reduction in carbon dioxide emissions in 2020 is roughly 21 percent in

---

[33] S. Palstev, J.M. Reilly, H.D. Jacoby, A.D. Ellerman, and K.H. Tay, *Emissions Trading to Reduce Greenhouse Gas Emissions in the United States: The McCain-Lieberman Proposal*, Report No. 97 (Cambridge, MA: MIT Joint Program on the Science and Policy of Global Change, June 2003 [revised June 17]).

Table S.8. Comparison of Key Results from the EIA and MIT Analyses of S.139

	2000[a]	2010	2015	2020	2025
Greenhouse Gas Emission Allowance Price (2001 dollars per metric ton carbon equivalent)					
MIT, McL Case	—	78	102	134	NA
EIA, S.139 Case	—	79	119	178	221
EIA, High Technology S.139 Case	—	59	88	133	158
Fossil Fuel Use (quadrillion Btu)					
MIT, Base Case					
Coal	22.75	26.54	28.43	32.23	NA
Oil	36.96	41.70	45.49	47.39	NA
Natural Gas	20.85	22.75	24.64	25.59	NA
EIA, Reference Case					
Coal	22.58	25.47	26.68	27.88	29.86
Oil	38.40	44.45	48.47	52.15	56.11
Natural Gas	24.06	27.35	30.07	32.95	35.55
EIA, High Technology Reference Case					
Coal	22.58	24.85	25.56	26.05	26.89
Oil	38.40	43.82	47.09	49.95	53.29
Natural Gas	24.06	26.62	28.45	30.33	32.35
Petroleum Use (quadrillion Btu, unless otherwise noted)					
MIT, Base Case	—	41.70	45.49	47.39	NA
MIT, McL Case	—	36.96	38.86	39.81	NA
Percent Change from Base Case	—	-11.4%	-14.6%	-16.0%	NA
MIT, McL Case Emissions Allowance Price for Motor Gasoline (2001 cents per gallon)	—	18.55	24.14	31.77	NA
EIA, Reference Case	—	44.45	48.47	52.15	56.11
EIA, S.139 Case	—	43.74	46.62	48.65	50.76
Percent Change from Reference Case	—	-1.6%	-3.8%	-6.7%	-9.5%
EIA, S.139 Case Emissions Allowance Price for Motor Gasoline (2001 cent per gallon)	—	18.68	28.08	42.23	52.26
EIA, High Technology Reference Case	—	43.82	47.09	49.95	53.29
EIA, High Technology S.139 Case	—	43.30	45.79	47.45	49.41
Percent Change from High Technology Reference	—	-1.2%	-2.8%	-5.0%	-7.3%
EIA, High Technology S.139 Case Emissions Allowance Price for Motor Gasoline (2001 cents per gallon)	—	13.91	20.91	31.45	37.53

[a]MIT estimates for 2000 oil use are from 1.0 to 3.8 quadrillion Btu below EIA data for 2000; MIT estimates for 2000 natural gas use are from 2.7 to 3.7 quadrillion Btu below EIA data for 2000.

NA = not available.

Sources: **MIT:** S. Palstev, J.M. Reilly, H.D. Jacoby, A.D. Ellerman, and K.H. Tay, *Emissions Trading to Reduce Greenhouse Gas Emissions in the United States: The McCain-Lieberman Proposal*, Report No. 97 (Cambridge, MA: MIT Joint Program on the Science and Policy of Global Change, June 2003 [revised June 17]), Base Case and Case 7 (0-cost credits to 15 and 10 percent limits), Tables 5 and 7. **EIA:** Projections—Office of Integrated Analysis and Forecasting, National Energy Modeling System runs MLBASE.D050303A, MLBILL.D050503A, MLBASE_HT.D052003C, and ML_HT.D050503A; 2000 Fossil Fuel Use—Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035(2003/04) (Washington, DC, April 2003), Table 1.3, web site http://tonto.eia.doe.gov/FTPROOT/multifuel/mer/00350304.pdf.

both studies. With a greater reduction in energy use in the MIT study, less fuel switching is needed to arrive at the same reduction in emissions.

Scope of This Report

The EIA analysis of S.139 contained in this report, like other EIA analyses, focuses on the impact of the provisions in the bill on energy choices made by consumers in all sectors and the implications of those decisions for the economy. This focus is consistent with EIA's statutory mission and expertise. The study does not quantify, or place any value on, possible health and environmental benefits of curtailing greenhouse gas emissions.

Appendix A

Request Letters and Other Correspondence

Original Request Letter from Senator James M. Inhofe

,/2003 19:09 FAX 002

JAMES M. INHOFE
OKLAHOMA
WASHINGTON OFFICE
453 RUSSELL SENATE OFFICE BLDG.
WASHINGTON, DC 20510-3603
202-224-4721
TULSA OFFICE
1924 S. UTICA, SUITE 530
TULSA, OK 74104
918-748-5111
OKLAHOMA CITY OFFICE
1900 N.W. EXPRESSWAY, SUITE 1210
OKLAHOMA CITY, OK 73118
405-608-4381

United States Senate
WASHINGTON, DC 20510-3603

COMMITTEES:
ARMED SERVICES
ENVIRONMENT AND PUBLIC WORKS
INDIAN AFFAIRS
INTELLIGENCE

January 28, 2003

The Honorable Guy F. Caruso
Administrator
Energy Information Administration
1000 Independence Avenue, SW
Washington, DC 20585

Dear Mr. Administrator:

I hereby request that the Energy Information Administration (EIA) analyze the Climate Stewardship Act of 2003 (S. 139), recently introduced by Senators Lieberman and McCain.

This bill would require significant reductions in emissions of the six gases identified in the Kyoto Protocol. The electricity, transportation, industrial and commercial sectors of the economy would be impacted.

I am particularly interested in the following EIA analyses, all of which should include measurability of the effect, margin of error of the calculation, factors included in the calculation, and relative certainty of the range of projections:

1. Effect on global temperature;
2. Using the assumptions of Dr. James Hansen's citation in *Proceedings of the National Academy of Sciences of the United States of America*, June 16, 2000, of Malakoff, D. (1997) *Science* **278,** 2048, and Wigley, T. M. L. (1998) *Geophys. Res. Lett.* **25,** 2285–2288, the number of S. 139-equivalent programs that would be needed to reduce theoretical projections of temperature increase to acceptable levels;
3. Cost of the growth of government entailed;
4. Cost to the U.S. economy both in terms of jobs and dollars;
5. Demographic spread of economic costs, with attention to income level and minority status;
6. Comparison of the compliance period of S. 139 to the specific scheduled commitments currently adopted by China, Mexico, South Korea, India, and Brazil to limit or reduce emissions of the Kyoto Protocol gases;
7. Energy suppression effects;
8. Comparison, in terms of both effects and costs, of the efficiency of S. 139's regulatory mechanisms to the efficiency of a BTU tax mechanism.

Any further details of the analysis can be addressed with Aloysius Hogan at 202-224-3107. I would appreciate it if you would comply with this request by Friday, April 4, 2003. Thank you in advance for your cooperation. I believe such EIA analysis will be essential to ensuring an informed debate on this issue.

Sincerely,

U.S. Senator James M. Inhofe
Chairman
Committee on Environment and Public Works

PRINTED ON RECYCLED PAPER

Original Request Letter from Senators Joseph I. Lieberman and John McCain

2003-004898 4/11 P 2:47

004898

United States Senate
WASHINGTON, DC 20510

April 2, 2003

Mr. Guy Caruso
Administrator
Energy Information Administration
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Dear Administrator Caruso:

We are writing to request an analysis of the projected economic impact of S. 139, the *Climate Stewardship Act*, which we introduced on January 9, 2003. It is our intention to request the Environmental Protection Agency (EPA) to conduct a similar analysis.

The bill would require the Administrator of the EPA to promulgate regulations to limit the greenhouse gas emissions from the electricity generation, transportation, industrial, and commercial economic sectors as defined by EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks*. The bill also would provide for the trading of emission allowances and reductions through a proposed greenhouse gas database established by the federal government, which would contain an inventory of emissions and a registry of reductions.

The legislation includes a number of key provisions that we want to call to your attention as EIA works to carry out a comprehensive analysis of the legislation's impact. We also request that you consider several recommendations on how certain factors might best be integrated into your review. These include:

- Allocation. The bill requires the Secretary of Commerce to determine the percentage of allowances that will be granted to covered entities, and the amount that would be allocated to the Climate Change Credit Corporation for auctioning. We request EIA evaluate a range of alternatives for these allocation percentages.

- Foresight. The legislation is designed to provide incentives to enable smooth adjustments through the program's inception in 2010, and specifically includes incentives for early action compliance efforts. Please evaluate the impact of such early action on the costs of compliance.

- Technological response. The bill allows for the deployment of new technologies to reduce greenhouses gas emissions. Please evaluate a range of technological responses, the effect of each response on the cost of compliance, and the perceived likelihood of that response.

Original Request Letter from Senators Joseph I. Lieberman and John McCain (continued)

- Banking of allowances. The legislation allows an entity that has satisfied its yearly emission requirements to hold any remaining tradeable allowances for future uses. Please evaluate how covered entities that choose to bank allowances for future use would impact the cost of the program.

In addition to the above mentioned provisions, S. 139 also contains a number of "flexibility mechanisms" that are intended to allow a covered entity to select the most cost-effective compliance method available that best meets the unique circumstances of that entity. Attachment A provides a summary of these "flexibility mechanisms."

In carrying out this analysis, we request that EIA employ the most accurate baseline scenarios available. Please use emissions data and projections consistent with existing U.S. policies and measures and the U.S. Climate Action Report 2002 projections. Moreover, for projected emissions from the utility sector, please include all committed new capacity currently available, including all new units in operation, all new units physically under construction, and other units in the development process that are clearly committed to future operation.

We further request that EIA identify all key assumptions used in the analysis. In addition, please conduct a sensitivity analysis of the program's overall cost to the various assumptions and variables.

We understand that this is an extremely comprehensive request and hope you appreciate that our goal is to ensure that the analysis provides the maximum amount of information on which to evaluate the ability of S. 139 to effectuate its goals. We would be pleased to further discuss this request, including its format and summary, at your convenience, and would appreciate receiving a written response informing us how EIA intends to conduct this analysis. In the meantime, if you have any questions or concerns regarding this request, please contact Tim Profeta of Senator Lieberman's staff at 202-224-5016 or Floyd DesChamps with Senator McCain's staff at 202-224-8172.

Thank you very much for your time and attention to this request.

Sincerely,

John McCain
U.S. Senator

Joseph I. Lieberman
U.S. Senator

Original Request Letter from Senators Joseph I. Lieberman and John McCain (continued)

Attachment A. Flexibility Mechanisms of S.196

The flexibility provisions contained in S. 139 would:

- Allow covered entities to achieve compliance through reductions in non-CO_2 greenhouse gases (CH_4, N_2O, HFCs, PFCs and SF_6). In addition, covered entities may offset their emissions via reductions from non-covered sectors and entities up to the 15% and 10% offset limits for the first and second target periods, respectively. We request that in evaluating the opportunities for compliance through the non-CO_2 gases, EIA bases its findings on fully developed and tested marginal abatement curves, such as those developed by EPA or Energy Modeling Forum at Stanford University.
- Allow unlimited trading among and between sectors.
- Allow covered entities to offset their emissions, up to the 15% and 10% offset limits, by trading with verified inventories in other countries.
- Include an incentive program to encourage automobile manufacturers to increase the fuel economy of autos, as well as offset provisions that will encourage additional demand-side reductions in the electricity sector from non-covered sources.
- Ensure entities engaging in approved geological sequestration projects are not required to turn in allowances for sequestered emissions.
- Allow covered entities to offset their emissions, up to the 15% and 10% offset limits, through biological sequestration achieved through both forestry and agricultural practices.
- Allow covered entities to offset their emissions, up to the 15% and 10% offset limits, by purchasing registered credits from nonparticipating entities.
- Allow covered entities to offset their emissions, up to the 15% and 10% offset limits, by borrowing future reductions up to five years in advance, as long as the future allowances are repaid at a 10 percent interest rate.
- Allow early participants – entities that pledge to reduce their emissions to 1990 levels before 2010 – to raise their use of allowed offsets to 20 percent.

E-Mail from Aloysius Hogan of Senator Inhofe's Committee
(Requesting a Run That Excludes Nuclear and Geologic Sequestration as Options and Delays an Earlier Request To Run a Sensitivity Evaluating a Btu Tax Mechanism)

From: Aloysius_Hogan@epw.senate.gov
[mailto:Aloysius_Hogan@epw.senate.gov]
Sent: Wednesday, April 23, 2003 6:32 PM
To: Mary.hutzler@eia.doe.gov
Subject: Analysis requested by Senator Inhofe

Please perform a model run that excludes nuclear and geologic sequestration which are as of yet not authorized in law and are of indeterminate political acceptability.

In an effort to complete this suite of analyses in a timely fashion, please hold the greenhouse gas tax mechanism/BTU tax mechanism analysis until after the other analyses are complete.

Thank you.

Aloysius Hogan
Chief Counsel
US Senate Environment and Public Works Committee
410 Dirksen Senate
Office Building
Phone: 202-224-6176
Fax: 202-224-5167
E-mail: aloysius_hogan@epw.senate.gov

E-Mail from Floyd Deschamps of Senator Mccain's Staff

(Refining Their Request To Include: Running a Sensitivity That Examines Greater Flexibility in Offsets Than the Current 15 Percent Amount; and Asking EIA To Base Its Non-CO_2 Gas Estimates on Projected Emissions of High-GWP Gases Rather Than Production Levels)

-----Original Message-----
From: DesChamps, Floyd (Commerce)
[mailto:Floyd_DesChamps@commerce.senate.gov]
Sent: Friday, May 02, 2003 3:32 PM
To: mary.hutzler@eia.doe.gov
Cc: Profeta, Tim (Lieberman)
Subject: EIA Analysis of S.139

In our initial memo, we requested EIA to inform our process by conducting a sensitivity analyses. Through this e-mail, we would like to convey specific runs that would be helpful to us. They are:
1) Please include greater flexibility for offsets than the current 15 percent amount (e.g. run 50 percent and full flexibility scenarios); and
2) Regarding non-CO2 gases, please base your estimates on projected emissions of High-GWP gases (not on production levels).

Thanks for your assistance. Please call me with any questions at 22-8172.

E-Mail from Aloysius Hogan of Senator Inhofe's Committee
(Requesting That a Sensitivity Be Run That Includes Higher Natural Gas Prices Based on a More Pessimistic Outlook for Natural Gas Supplies)

-----Original Message-----
From: Hogan, Aloysius (EPW) [mailto:Aloysius_Hogan@epw.senate.gov]
Sent: Thursday, June 05, 2003 6:05 PM
To: mary.hutzler@eia.doe.gov
Subject: Higher gas price analysis

Per our discussion, please include in your analysis of the Lieberman/McCain bill a scenario with higher natural gas prices. Such a scenario could result from Coastal Zone Management Act consistency appeals difficulties in permitting LNG facilities, difficulties in obtaining natural gas in the lower 48 states from Alaska, difficulties associated with Canada's compliance with the Kyoto Protocol, difficulties in developing America's resources on the Outer Continental Shelf, and other possible difficulties.

Please know that time is of the essence, however, with *possible* floor action during the week of June 9. As such, no such analysis should delay the utility of the EIA analysis *in toto* for floor debate.

Aloysius Hogan
Chief Counsel
US Senate Committee on Environment & Public Works
Direct Phone: 202-224-3107
Fax: 202-224-5167